United States Circuit Courts.

IN EQUITY.

SOUTHERN DISTRICT OF NEW YORK:

THE AMERICAN BELL TELEPHONE COMPANY, et al.

vs.

THE OVERLAND TELEPHONE COMPANY, et al.

DISTRICT OF NEW JERSEY:

THE AMERICAN BELL TELEPHONE COMPANY, et al.

vs.

THE OVERLAND TELEPHONE COMPANY OF NEW JERSEY, et al.

EASTERN DISTRICT OF PENNSYLVANIA:

THE AMERICAN BELL TELEPHONE COMPANY, et al.

vs.

THE PENN OVERLAND TELEPHONE COMPANY, et al.

EVIDENCE FOR COMPLAINANTS IN REPLY.

BOSTON:
ALFRED MUDGE & SON, LAW PRINTERS, 24 FRANKLIN STREET.
1885.

EVIDENCE FOR COMPLAINANTS IN REPLY.

IN THE UNITED STATES CIRCUIT COURT,

FOR THE SOUTHERN DISTRICT OF NEW YORK.

IN EQUITY.

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v.

THE OVERLAND TELEPHONE COMPANY ET AL.

IN THE UNITED STATES CIRCUIT COURT,

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v.

THE OVERLAND TELEPHONE COMPANY, THE OVERLAND TELEPHONE COMPANY OF NEW JERSEY ET AL.

IN THE UNITED STATES CIRCUIT COURT,

FOR THE EASTERN DISTRICT OF PENNSYLVANIA.

IN EQUITY.

THE AMERICAN BELL TELEPHONE COMPANY ET AL.

v.

THE OVERLAND TELEPHONE COMPANY, THE PENN OVERLAND TELEPHONE COMPANY ET AL.

Evidence on behalf of complainants, in reply, taken before Fred. M. Ott, special examiner, at No. 40 State Street, Boston, Mass., Oct. 2, 1885, 10 A. M., pursuant to notice, hereto appended.

Present: Mr. STORROW, for complainants.

FRANK L. POPE, being produced, sworn and examined, saith: —

Examined by Mr. STORROW.

I am forty-four years of age; I reside at El Mora, Union County, N. J.; and my place of business is at 11 Wall Street, in the city of New York; I am an electrical engineer by profession, and my present occupation is that of a solicitor of patents.

Int. 1. Are you the same Mr. F. L. Pope who testified for complainants in the Drawbaugh case, the record of which, including your deposition, has been stipulated into these cases?

Ans. I am.

Int. 2. Did you, as expert for the complainants, attend some tests at Philadelphia, Feb. 6, 1885, and concerning which Prof. Barker has testified for respondents?

Ans. I did.

[*Complainants put in evidence, in accordance with the stipulation printed with respondents' proofs, short-hand reports of the said tests, taken by short-hand reporters employed by complainants, one in the transmitting room and one in the receiving room* (v. p. 500, *infra*).]

Int. 3. Which room were you in during those tests?

Ans. I was in the transmitting room.

Int. 4. I believe that you then carefully examined the instruments used, and that you have again carefully examined them this morning in the hands of Mr. Ott, the examiner. Will you please state how the several instruments, by means of which speech was transmitted at the said Philadelphia tests, compare with the correspondingly lettered instruments by means of which speech was attempted to be transmitted at the New York tests, made at the rooms of the People's Telephone Company, New York, March 28, 29, 30, 1882?

Ans. I have compared the instruments referred to in the question, very carefully, part by part. The Philadelphia instruments are constructed in a much more thorough and workmanlike manner than the New York instruments, and are in general much better finished. Every separate part of each of the Philadelphia instruments is of better workmanship and better proportion than the corresponding parts of the New York instruments. One very important point

of superiority in the Philadelphia instruments is the rigidity of all the parts intended to be fixed, and the greater accuracy of movement of the adjustable parts, thus affording an adjustment which is positive, and which may be relied upon to maintain itself, while at the same time it may be made very delicate.

In respect to the transmitters, I noted especially that the diaphragms were well made, carefully fitted into their seats and rigidly clamped; that the rods were securely fastened, and the plunger very accurately fitted, yet capable of moving freely within the chamber containing the carbon powder. All these improvements are of a character to greatly increase the efficiency of the apparatus.

Int. 5. What was the character of the powders used in the two tumbler transmitters employed in the Philadelphia test?

Ans. The powders were apparently of hard carbon, of different degrees of fineness. They were all of a granular or sandy character, as distinguished from a fine, smooth or floury quality.

Int. 6. How were the tumbler transmitters held or supported while speech was being transmitted through them at the Philadelphia tests?

Ans. During that portion of the time when speech was being heard and understood, the speaker invariably held the tumbler transmitter in his hand, inclining it towards himself at an angle of about forty-five degrees, with the opening of the mouthpiece about one inch from his mouth.

Int. 7. Please describe the loudness with which he spoke into the transmitter of the tumbler form.

Ans. The speaker, who for the greater part of the time was Mr. Hill, articulated clearly and distinctly, sentence by sentence, with his voice somewhat raised above a conversational tone, though not particularly loud.

Int. 8. Have you, since those Philadelphia tests, attempted to transmit speech with an apparatus composed of a tumbler transmitter like the so-called reproductions of "F," and a tin-can receiver like the so-called reproductions of "B," using granular carbon powder, and holding the tumbler transmitter in the position, and using it in the same manner in which it was used at the Philadelphia tests;

and if so, with what results as regards the intelligible transmission of speech?

Ans. I have made some experiments with a tumbler transmitter of the kind referred to in the question, coupled with a tin-can receiver; the latter being a carefully constructed instrument, perhaps as well made as such an instrument could be. With a coarse carbon powder in the transmitter, which would just pass through a No. 50 sieve, the articulation was quite good when the transmitter was held at an angle in the hands of the speaker, although the sounds were weak and frequently too faint to be well heard. With a finer powder, about No. 120, the volume of sound was too faint to be heard with three cells of Fuller battery, but with six cells could be heard quite fairly, so as to be understood without difficulty.

Int. 9. With the same instruments, and under the same circumstances, what did you find to be the effect of placing the tumbler transmitter on a table, so that the diaphragm and cup were horizontal?

Ans. When the transmitter was placed in a horizontal position, the tones became gradually louder, and at the same time the articulation began to fail, the tones becoming more and more of a nasal and what may be called a scratching character. In a few moments the words became unintelligible, soon after which the sounds usually failed altogether. When the transmitter was readjusted, still in the same position, a word or two could be understood, but no more.

Int. 10. When speech had thus failed, what effect did merely taking up the transmitter and tipping it in the hand to an inclination of say forty-five degrees, and speaking into it in that position, have upon it?

Ans. It restored the articulation at once, so that it became as good as at first.

Int. 11. Of what material were the diaphragms of the tumbler transmitters used in the Philadelphia tests?

Ans. Of sheet metal, apparently German silver or tinned iron.

[*Complainants put in evidence copies of two United States patents for telephone transmitters granted to Henry Hunnings, No.* 246,512, *Aug.* 30, 1881, *and* 250,250, *Nov.* 29, 1881.]

Int. 12. Do you know that Hunnings instrument, and have you used it?

Ans. I am acquainted with the instrument, and have used it.

Int. 13. Is it a loud speaker or not?

Ans. A very loud speaker, with excellent articulation.

[*Complainants produce the following assignments of said patents, to wit: No.* 246,512, *Henry Hunnings to George L. Anders, dated Aug.* 31, 1881, *recorded at the Patent Office, Aug.* 31, 1881, *Liber M.* 26, *page* 423, *and assignment of the same, George L. Anders to the American Bell Telephone Company, dated Aug.* 31, 1881, *recorded at the United States Patent Office, Aug.* 31, 1881, *Liber M.* 26, *page* 422; *also an assignment of patent* 250,250, *Henry Hunnings to George L. Anders, dated Dec.* 29, 1881, *recorded in the United States Patent Office, Jan.* 23, 1882, *in Liber S.* 27, *page* 337; *also assignment of the same by George L. Anders to the American Bell Telephone Company, dated Dec.* 29, 1881, *and recorded in the United States Patent Office, Jan.* 23, 1882, *in Liber S.* 27, *page* 337.]

Int. 14. Were you in the receiving room at all, or did you listen at the receivers during the Philadelphia tests?

Ans. I did not go into the receiving room nor listen at the instruments during the tests.

FRANK L. POPE.

Sworn and subscribed to, before me, this second day of October, 1885.

FRED. M. OTT, *Special Examiner.*

[*Recess until* 2 P. M.]

[*Deposition of Mr. Pope suspended at this point.*]

FRANK L. POPE, being recalled for cross examination, saith: —

Cross Examination by Mr. MELVILLE CHURCH.

Cross-Int. 15. Have you ever tested the identical instruments of the "F" form and the "B" form used at the Philadelphia tests, and in respect to which Prof. Barker has testified for defendants?

Ans. I have not.

Cross-Int. 16. Who made the alleged reproductions of those instruments, used by you, as you have testified in your direct examination?

Ans. I do not know.

Cross-Int. 17. Do you know when they were made?

Ans. I do not, but think quite recently, from their appearance.

Cross-Int. 18. Have you ever compared them, side by side and part by part, with the instruments which were used at the Philadelphia tests?

Ans. I have not compared them in that way.

Cross-Int. 19. You cannot, then, testify to the instruments which you used being exact duplicates of those used at the Philadelphia tests, can you?

Ans. They are pretty close copies of them. I examined the Philadelphia instruments carefully, at the time the tests were made last year, making sketches and measurements of them, and I referred to those notes when experimenting with the reproductions. Still, I did not specially examine the reproductions that I used, to make sure that they were exact duplicates in every particular.

Cross-Int. 20. Who was present, if any one, when you made your tests of the instruments furnished you for that purpose?

Ans. Mr. Jacques, Prof. Arthur Wright, and, part of the time, Mr. Storrow.

Cross-Int. 21. Where were the tests made?

Ans. In Mr. Jacques's office, 95 Milk Street, Boston.

Cross-Int. 22. Was the instrument of the "F" form, employed at the Philadelphia tests, ever attempted to be used there, while on a table or other substantially horizontal support?

Ans. Not that I remember.

Cross-Int. 23. You do not know, then, whether or not that instrument would practically operate in that position, do you?

Ans. Not from experience.

Cross-Int. 24. When did you first become familiar with the Hunnings invention, concerning which you have testified?

Ans. I first saw it some time within two years; I cannot recollect the particular time.

Cross-Int. 25. Do you mean by your last answer that your first knowledge of the Hunnings invention was obtained within the last two years?

Ans. Not exactly. I read an account of the instrument in some electrical journal, some three or four years ago; but it made little, if any, impression on my mind until I heard the instrument talk, which have may been a year and a half ago, more or less.

Cross-Int. 26. Your business as an electrical expert has required you to keep well posted in regard to improvements in telephony, during the past eight or nine years, has it not?

Ans. I keep as well posted as possible, and think I am acquainted with nearly all inventions in that line which have proved to be of practical value.

Cross-Int. 27. You have had occasion, have you not, to investigate the state of the art of telephony during the past four or five years?

Ans. I have.

Cross-Int. 28. And have examined the English as well as the American patents on that subject, have you not?

Ans. A portion of them.

Cross-Int. 29. Had you not, in the course of your investigation, prior to a year and a half or two years ago, seen the English patent to Hunnings, dated in 1878, or either of his United States patents, dated respectively Aug. 30, 1881, and Nov. 29, 1881?

Ans. I had seen one or both of the United States patents, but I have no recollection of having examined the English patent.

Cross-Int. 30. Did you ever, prior to a year and a half or two years ago, give any opinion or advice in respect to this Hunnings invention?

Ans. I think not; I have no recollection of so doing.

Cross-Int. 31. When did you first see one of the Hunnings instruments, or an instrument constructed in accordance with his invention?

Ans. I believe it was early in the present year that I first saw the Hunnings instrument; but I had heard speech transmitted from the instrument a year and a half ago, more or less.

Cross-Int. 32. How did you know that the Hunnings instrument was used, at the time you heard speech transmitted from it, as you have just testified?

Ans. I was told so; I did not see it myself.

Cross-Int. 33. Where did this take place?

Ans. I think it was in the room where we now are.

Cross-Int. 34. Before or after the tests at Philadelphia?

Ans. I cannot recollect; but it is my impression that it was not far from that time.

Cross-Int. 35. You have testified, I believe, that the Hunnings instrument is a loud talker?

Ans. Yes.

Cross-Int. 36. Will you please describe the construction of the Hunnings instrument which you have used, and which is what you have called a loud talker?

Ans. I have never personally used the transmitter, but in my tests have listened while others spoke into it. I have not, on any of these occasions, examined the interior of the transmitter, and cannot describe it, except as its construction was explained to me by others.

Cross-Int. 37. In answer to Int. 12, you said that you were acquainted with the Hunnings instrument, and had used it. How do you reconcile that statement with the testimony just given?

Ans. I suppose listening to an instrument to be one way of using it. At all events, that use was that I had in my mind in giving my direct testimony.

Cross-Int. 38. From what you have testified on this subject, I take it, you have not personal knowledge of the Hunnings instrument, which you say you have heard speech from, sufficient to enable you to describe it. Am I correct in this?

Ans. Not the particular instruments with which the experiments were conducted. I understand the principle and mode of operation of the Hunnings transmitter in general, but did not think it necessary to examine the interior of the particular instruments used at the time.

Cross-Int. 39. You have never had a Hunnings instrument in your hand to talk through it, have you?

Ans. I think not.

Cross-Int. 40. Was the Hunnings instrument which you have seen apparently connected up with a circuit, for practical operation?

Ans. It was.

Cross-Int. 41. Was it connected in a manner to lead you to suppose that any particular position of it was necessary while in operation?

Ans. It was connected so that it might be placed in any position; and this was done for the purpose of observing the effect of different positions of the transmitter upon the character of speech heard in the receiver.

Cross-Int. 42. Have you any personal knowledge, derived from your experience with the instrument, or from your personal observation of it, as to the position in which it must be placed to enable it to transmit speech?

Ans. I have. The speaker was so situated that I could see him and see how he held the transmitter, while at the same time I could not hear him except through the receiver, which was placed in an electrical circuit with the transmitter. This enabled me to determine the actual effect of placing the transmitter in different positions.

Cross-Int. 43. Tell us what effect different positions had upon the articulation, so to speak, of the instrument?

Ans. So long as the instrument was held in an inclined position, the articulation was excellent; when placed in a position with the diaphragm horizontal, or nearly so, the tones became of a nasal character, with a gradually increasing scraping or scratching noise. This increased to such an extent as to prevent the words from being understood after the transmitter had been for a few moments in a horizontal position. Upon restoring the transmitter to an inclined position, the articulation was nearly or quite as good as at first.

Cross-Int. 44. Could you see the diaphragm from where you stood?

Ans. No; but I could see the exterior of the instrument plainly.

Cross-Int. 45. What was the shape of the instrument?

Ans. Cylindrical, with the mouthpiece at one end of the cylinder.

Cross-Int. 46. Was the diaphragm at right angles to the length of the cylinder?

Ans. Yes.

Cross-Int. 47. How do you know this?

Ans. I saw it.

Cross-Int. 48. Of what was the diaphragm composed, and what was its shape?

Ans. It was apparently of metal, and in the shape of a thin disk. I could see it through the opening of the mouthpiece, but did not otherwise examine it.

Cross-Int. 49. Of what metal was it composed?

Ans. I do not recollect.

Cross-Int. 50. Was it perforate or imperforate?

Ans. I do not recollect distinctly, but think it was imperforate.

Cross-Int. 51. While the instrument was in horizontal position, that is, with its diaphragm horizontal, and after its articulation became less plain, what effect did a tapping or slight shaking of it have upon its operation?

Ans. It would sometimes momentarily restore the articulation, so that two or three words could be heard, but not always.

Cross-Int. 52. You did not, of course, observe how much or how little carbon, if any, was contained within that instrument, did you?

Ans. I observed the kind of carbon that was used in it, but not the amount.

Cross-Int. 53. Was the instrument opened before you?

Ans. It was opened while I was in the room: I might have been ten or fifteen feet distant. I saw it opened, but was not near enough to observe the operation particularly.

Cross-Int. 54. Nor to observe its internal construction, if I understand you correctly.

Ans. No, I did not.

Cross-Int. 55. You have examined the Hunnings patents, put in evidence, have you not?

Ans. Not very recently.

Cross-Int. 56. I ask you now to look them over.

[*Witness examines patents.*]

Ans. I have examined the patents, as requested.

Cross-Int. 57. Does the patentee state in either of them that it is essential that any particular position of the diaphram, or of the instrument as a whole, be observed in order to transmit speech by means of it?

Ans. I do not understand that he does.

Cross-Int. 58. Does he, in either patent, state of what degree of fineness the carbon he proposes to employ must be?

Ans. He does not, further than the general direction that it shall be fine, loose powder, not in any way compressed or consolidated, and that it shall be crushed, and not ground so as to pulverize the particles.

Cross-Int. 59. Does, in your opinion, the omission of specific directions as to how to hold the instrument, or as to the degree of fineness of the carbon, affect the validity of either of these patents, or prevent the invention being practised from the description given in the patents, or either of them?

[*Question objected to as a mis-statement of the patents.*]

Ans. In my opinion, it does not.

[*Recess until* 1.30 P. M.]

Cross-Int. 60. In answer to the ninth direct question, you stated, in substance, in reference to the transmitter with which you experimented after the Philadelphia tests, that when the instrument was placed in a horizontal position, the tones became more and more of a nasal character, and that in a few moments the words became unintelligible; from which I gather, that for a few moments, at least, the instrument did, while in such horizontal position, transmit speech, though not so well, perhaps, as when in an inclined position. Am I correct in this?

Ans. Yes; a few words could generally be understood after the

transmitter was placed in a horizontal position, though the articulation was poor.

Cross-Int. 61. Do you regard an instrument such as you experimented with, and while used in a horizontal position, and capable of transmitting a few words in succession, or of operating but a few moments only in transmitting speech, as one by which the method set forth in the fifth claim of the Bell patent of 1876 is practised?

Ans. So far as it operated at all, in my opinion, it operated by that method.

FRANK L. POPE.

Sworn and subscribed to, before me, this sixth day of October, 1885.

FRED. M. OTT, *Special Examiner.*

DFPOSITION OF CHARLES R. CROSS.

CHARLES R. CROSS, being produced, sworn and examined, saith: —

Examined by Mr. STORROW.

Int. 1. Are you the same Charles R. Cross who has already testified in these cases, and in the Drawbaugh case, in behalf of complainants?

Ans. I am.

Int. 2. Did you attend the tests of telephone instruments made at Philadelphia by the defendants, Feb. 6, 1885, about which Prof. Barker has testified?

Ans. I did.

Int. 3. Were you in the transmitting room, or in the receiving room, or both?

Ans. I was in the receiving room throughout the whole time when the experiments were in progress. I was in the transmitting room for a while before they began, and again after they had closed. I do not remember being in the transmitting room at any other time.

Int. 4. Did you listen at the receiver during any of those tests, or did anybody on behalf of the complainants listen at the receiver?

Ans. I did not listen at the receiver, nor did any one on behalf of the complainants.

Int. 5. Did you examine the powder used in the tumbler transmitters at those tests; and, if so, what was its physical character?

Ans. I examined the powder in one of the transmitters after the tests had closed. It consisted of carbon, granulated, but not very finely, so that it was gritty to the touch. I remember that some one, who was examining it with me, remarked that it was about No. 40; that is, that it was of such size as to pass through a sieve having forty meshes to the inch. The estimate seemed to me to be correct, and I acquiesced in it.

Int. 6. Have you, since those tests, endeavored to transmit speech with an apparatus composed of a tumbler transmitter of the form of the so-called reproductions of the Drawbaugh tumbler transmitter used in those tests, and a tin can receiver like the so-called "B reproduced," employing granulated carbon powder in the transmitter, and having the transmitter held in the hand of the operator in an inclined position? and, if so, did you transmit speech in that way?

Ans. I have tried such experiments, and have successfully transmitted speech with such an apparatus, operated in the manner described in the question.

Int. 7. With such an apparatus, so successfully transmitting speech, what is the effect of placing the tumbler transmitter on the table, with its diaphragm and carbon powder box horizontal, and without other change in the conditions?

Ans. I have repeatedly tried the experiment of changing the position of the transmitter from an inclined position and held in the hand, to a flat position resting on the table, and have found that, while speech was successfully transmitted with the tumbler transmitter held inclined in the hand, on placing it flat on the table the speech immediately became indistinct, and it became impossible to transmit anything except an occasional word or phrase. Removing the transmitter from the table, and holding it again in an inclined position, renewed the adjustment, so that speech was again transmitted as before.

Int. 8. Are you familiar with the Hunnings transmitter?

Ans. I am.

Int. 9. Do you know Frank W. Smith, and do you know whether he was at one time employed in the laboratory of the American Bell Telephone Company?

Ans. I am well acquainted with that Mr. Smith, and know that he was for some time in the employ of the American Bell Telephone Company, in their experimental laboratory.

Int. 10. While he was employed in their experimental laboratory, do you know whether the Hunnings transmitter was an instrument used there, and experimented with there?

Ans. The Hunnings transmitter was very frequently used and experimented with in the laboratory while Mr. Smith was employed there, Mr. Smith himself very frequently working with it.

Int. 11. How do you know that?

Ans. I have seen and used the instrument there in connection with Mr. Smith, among others.

Int. 12. When was this?

Ans. In the autumn and winter of 1881–82.

Int. 13. Do you know of his being in the employ of the People's Telephone Company or Drawbaugh Telephone Company; and, if so, what do you know about it, and how do you know?

Ans. I do. On the occasion of my first visit to the Philadelphia Electrical Exhibition, very early in September, 1884, I met Mr. Smith in the exhibition hall. He informed me that he was in the employ of the Drawbaugh Telephone Company, and said that he should be glad to show me their exhibit. I went with him to the case containing some apparatus which they had on exhibition, and looked at them for a short time. The instruments were then exposed to view. A few days afterwards I observed that the case was covered with a cloth, so as to screen the instruments from observation, and that a placard stated that they would not be exhibited to the public until after the hearing of the Drawbaugh case.

CHAS. R. CROSS.

Sworn and subscribed to before me, this second day of October, 1885.

FRED. M. OTT, *Special Examiner.*

Prof. CHARLES R. CROSS, being produced for cross examination, saith: —

Cross-examined by Mr. MELVILLE CHURCH.

Cross-Int. 14. In your answer to direct Int. 6, you speak of having made tests with an apparatus composed of a tumbler transmitter of the form of those used at the Philadelphia tests, and a tin can receiver like that also used at said last-named tests. I would like to ask you where these instruments which you so experimented with were made, and under whose direction?

Ans. The instruments were made some time in September last; I suppose that they were made in the workshop of the American Bell Telephone Company. I do not know who gave the specific order to the workmen.

Cross-Int. 15. Have you ever compared, side by side, those instruments with the ones which were used at the Philadelphia tests, with a view of ascertaining whether or not they corresponded in all respects to each other?

Ans. I have not done so.

Cross-Int. 16. You do not know, then, whether in all respects the instruments with which you experimented were duplicates of those used in Philadelphia; am I right in this?

Ans. Never having had an opportunity of comparing the Philadelphia instruments with those that I used in Boston, I cannot have that precise knowledge as to certain minute and unimportant points, which would not be likely to be observed without such comparison. I am certain, however, that in all material points the instruments that I used are identical with the Philadelphia instruments.

Cross-Int. 17. Are you also certain that the instruments which you used are, in all material points, identical with the corresponding instruments used at the New York tests, at which, I believe, you were also present?

Ans. My recollection at this time with regard to the exact condition of the New York instruments is less clear than with regard to the Philadelphia instruments. The instruments which I used were, however, substantially identical with the New York instruments, and, I am very certain, did not differ from them materially.

Cross-Int. 18. Have you not been the expert for the American Bell Telephone Company in all the suits which it has brought and prosecuted under the Bell patents?

Ans. I do not know. They have called upon me very frequently, but I have no knowledge from which I can say whether I have or have not been called upon in all their cases.

Cross-Int. 19. I understand from your testimony in chief, that at the Philadelphia tests you were stationed at the end of the line where the receivers were located, and that at no time while the instruments were being operated were you at the transmitting instruments; am I right?

Ans. So far as I can recollect; except at the very beginning, or rather, before the beginning of the tests, when some brief sentences were sent, using the tumbler transmitter, for the purpose of seeing that everything was in proper order. I was not in the transmitting room at all during the tests.

Cross-Int. 20. You were not in position, then, while the tests were going on there, to judge whether or not the position of the transmitting instruments affected their operation, were you?

Ans. I did not at the time know in what position the transmitter was held.

Cross-Int. 21. From whom did you get instructions to make the tests that were made after those tests at Philadelphia?

Ans. Mr. J. J. Storrow.

Cross-Int. 22. And what were your instructions in regard to making those tests?

Ans. I don't know that I had any special instructions, beyond the general understanding which I have always had when called upon by the Bell Company, to find out everything that there was to be known about the matter, if possible. Certain specific questions were discussed; among others, the effect of tipping the transmitter, and to these questions, I was given to understand, specific answers were to be sought.

Cross-Int. 23. According to your direct examination, you found by your tests that the transmitter with which you experimented worked better when its diaphragm was in an inclined or tipped position than when held in a horizontal position. Did you bend your

energies at all in the direction of endeavoring to improve the operation of the instrument when its diaphragm was substantially horizontal?

Ans. I tried very hard to make the transmitter work when its diaphragm was horizontal. I do not think that you do justice to the strength of my testimony in the statement at the beginning of your question.

Cross-Int. 24. Did you succeed in transmitting any sentences while the diaphragm was in a horizontal position?

Ans. By careful adjustment, with the diaphragm horizontal, occasional words and phrases, and sometimes brief and very familiar sentences, could be recognized at the receiver. These came only very infrequently, and by far the greater part of what was spoken into the transmitter when its diaphragm was horizontal was quite unintelligible. When the transmitter was operated in an inclined position, and then placed so that the diaphragm was horizontal, speech could sometimes be transmitted at first, although very indistinctly; but very soon it always ceased to be intelligible.

Cross-Int. 25. Could you not in any way adjust the instrument, while its diaphragm was in a substantially horizontal position, so as to restore its speech-transmitting quality?

Ans. Readjustment would oftentimes improve the action of the transmitter, so that something could be got through; but I have never been able to cause this adjustment to persist. In the case of fine, floury carbon powder, even repeated adjustment generally failed to enable me to transmit speech, except in the exceedingly indistinct and accidental manner which I have already described.

Cross-Int. 26. At what inclination of the instrument from the horizontal is it possible to transmit speech at all connectedly?

Ans. In all the experiments which I tried, the transmitter was held at an angle of about forty-five degrees. I do not know to what extent this angle could be diminished without practically destroying the action of the transmitter.

Cross-Int. 27. You are familiar with the construction of the tumbler instruments used at the tests, both at Philadelphia and New York: would not a deflection of the carbon box from a horizontal, or an arrangement of the carbon box and mouthpiece or cover, in

planes inclined more or less to each other, affect the operation of such instruments?

Ans. The operation of such instruments when inclined would, of course, as my experiments show, be different from their operation when horizontal. I think that a considerable inclination from a horizontal position of the diaphragm would be necessary to make the tumbler transmitter effective.

Cross-Int. 28. Does not the quantity of carbon contained within the carbon box materially affect the operation of transmitters such as you have been testifying about?

Ans. Doubtless it does, within certain limits.

Cross-Int. 29. And the more nearly full the carbon box, the less inclination from the horizontal is necessary, according to your theory, to the successful operation of the instrument; is this correct?

Ans. Your supposition is not correct.

Cross-Int. 30. And why?

Ans. I have not observed experimentally that such is the case, nor do I see any reason why there should be less packing of the carbon powder in proportion as the box is fuller. Provided, of course, that the tin diaphragm rests upon the carbon powder over substantially its whole area.

Cross-Int. 31. If the tin diaphragm, over its entire area, does not rest upon the powder, then, I take it, a greater inclination from the horizontal would be necessary, according to your theory, to secure favorable results, than if the whole area of the diaphragm rested upon the powder. Is this not true?

Ans. I think it is somewhat doubtful, though very likely it is to a certain extent true.

Cross-Int. 32. In experiments with new and crude forms of telephonic apparatus, has it been your experience that the best results are obtained first?

Ans. Certainly not, usually.

Cross-Int. 33. And does it not frequently happen that, with the same instrument, a subsequent test may prove entirely successful where a first one from some unaccountable reason has been unsuccessful?

Ans. This may, of course, happen. My experience, however, has rather been that later experiments have succeeded where earlier ones have failed, because of the discovery of the reason and the remedying of the defects which caused the failure.

CHAS. R. CROSS.

Sworn and subscribed to before me, this sixth day of October, 1885.

FRED. M. OTT, *Special Examiner.*

[*Counsel for complainants puts in evidence certified copies from the Post Office Department, to be marked "Complainants' Exhibits, Post Office Decisions about J. M. Boyle," consisting of three papers, which are also marked "Report of J. H. Brown, Post Office Inspector; Report of A. A. Freeman, Assistant Attorney General, Post Office Department," and "Order of the Postmaster General," respectively.*]

DEPOSITION OF CHARLES R. CROSS.

CHARLES R. CROSS, being produced, sworn and examined, saith: —

Examined by Mr. STORROW.

Int. 1. Are you the same Prof. Cross who has already testified in this case?

Ans. I am.

Int. 2. Did you testify for the complainants in the Dolbear case?

Ans. I did.

Int. 3. In the Dolbear case, some experiments were made in the presence of both parties by Prof. Dolbear and his assistants with instruments produced by him as *fac-similes* of transmitters and receivers constructed by Philip Reis in his lifetime. Did you witness those experiments and did you shortly afterwards describe them in a deposition that you gave in that case?

Ans. I witnessed the experiments and described them in a deposition in that case.

Int. 4. Will you read from that case the testimony you gave in

that deposition with reference to those experiments and the Reis apparatus, and state whether the facts therein stated are true?

Ans. The facts therein stated are true. I read them from my deposition as follows: —

"Testimony of PROF. CHARLES R. CROSS, given in Dolbear's case.

Int. 8. Have you read the publications by and relating to Reis which have been put in evidence by the defendants, and also those which have been put in evidence by the complainants?

Ans. I have done so.

Int. 9. Will you state whether the intention of Reis, as expressed by himself and others in their publications, was that his apparatus, when in use, should interrupt the current with a frequency corresponding to the pitch of the sound which actuated the transmitter, or whether it was that it should merely vary the current without ever interrupting it?

[*Objected to because a variation of the current by increasing the resistance seems to the defendants' counsel* [*in the Dolbear case*] *one form of interrupting the current.*]

Ans. The intention of Reis, as stated in the various authoritative publications regarding his apparatus, was that the current should be interrupted — that is, reduced to zero — once for each vibration of the membrane, in correspondence with the pitch of the sound acting upon the membrane, so that the strength of the current should vary intermittently from a finite quantity to zero.

Int. 10. Considering the mechanical action of the two electrodes in the various forms of the Reis apparatus shown in the publications, do those publications state the intention to be that the two electrodes should part company with a frequency corresponding with the pitch of the sound which actuated the membrane, or do they state the intention to be that they should never part company, but always remain in contact?

[*Objected to* [*by counsel for defendants in the Dolbear case*] *as not within the province of the witness.*]

Ans. The publications state distinctly that the intention is that the two electrodes shall be separated from each other and again brought into contact with a frequency corresponding with the pitch of the sound actuating the membrane.

Int. 11. Turning now to those portions of the publications which purport to state the facts learned by actual use and observation of the Reis transmitter when in action, do they state that in actual operation the electrodes do part company and interrupt the electric current, or do they state that in fact they do not part company and do not interrupt the current?

Ans. They state that, as a matter of fact, in the operation of the

instrument the electrodes do part company and so interrupt the current.

Int. 12. In several places in his deposition, particularly on pages 379 and 426, Prof. Dolbear undertakes to draw a distinction between breaking the contact and interrupting the current, and intimates that a statement that the contact was broken would not necessarily imply that the current was interrupted. Will you tell me whether, in the Reis publications, the precise phrase used to express the action of the apparatus upon the current is "breaking the contact," or whether it is, "interrupting the current"?

[*Objected to, as the intimation set forth is not, in the opinion of defendants' counsel [in the Dolbear case], found anywhere in Prof. Dolbear's deposition.*

Complainants quote from page 379: "*A distinction must, therefore, be kept in mind between a* break of contact *and a* break in current. *A* break of contact *does not imply a* break in current."]

Ans. The statement made in the Reis publications as to the operation of the apparatus in the original German is, that the *current* is *broken*, not simply that there is a break of *contact* or an interruption in the *circuit*.

Int. 13. If, in those parts of the publications which purport to state what was observed in the actual use and observation of the Reis apparatus when in action, you find stated any observed facts which go to show whether the apparatus did habitually break the current in the manner stated, will you please to mention some of those facts?

Ans. The transmitting apparatus of Reis is described as showing a spark at the contact points of the electrodes when the apparatus was in operation. The production of this spark is an evidence that the electrodes have parted contact. Also a rattling sound is described as proceeding from the electrodes, which indicates a parting of contact. Still further, the sound produced by the Reis receiver is described as being audible throughout a large room. This could happen only when the transmitter operated by breaking the circuit.

Int. 14. It appears from the statements in the Reis publications, and from the measurements introduced in evidence yesterday by the defendants' witness, Mr. Eaton, that the circuit employed by the various writers referred to employed a moderate length of line wire, three cores with coils inside them, the total resistance of the three being between three and four ohms, and two or three cells of battery, and a transmitter. In such an apparatus, would breaking the contact of the electrodes sufficiently to interrupt the battery current produce a spark at the break; and would a visible spark be there produced without interrupting the battery current?

Ans. A visible spark would not be produced by this apparatus unless the battery current was interrupted; and an interruption of

the battery current would generally, and probably always, produce a spark.

Int. 15. If the apparatus operated in the manner described in the various publications, as stated in your previous answers, would it, when so operated, transmit articulate speech?

Ans. It would not.

Int. 16. It has appeared that the hopping electrode of the *Reis transmitter* weighs about seventeen grains, and that in the modern articulating microphones produced, the electrode not attached to the diaphragm weighs from seventy-five to four hundred and sixty-five grains.

Will you tell me whether this marked difference in physical structure adapts the one instrument to break the circuit and interrupt the current and the other to vary the current without interrupting it, when the same voice is applied to vibrate the diaphragms of both; and which structure is adapted for one purpose, and which for the other, and give your reasons?

Ans. The difference in structure referred to in your question is a matter of great importance. If the electrodes when actuated by the voice are to part company and so interrupt the current, they should be, and as a matter of fact, always have been made light, and caused to rest lightly upon each other.

This being the case, the impulse given by the vibrations of the voice will be sufficient to throw them out of contact with each other and thus secure the desired breaking of the circuit.

On the other hand, if the instrument is to be used as a variable resistance battery transmitter for the transmission of articulate speech, in which case the current must be simply varied and never interrupted, the electrode which is not attached to the diaphragm or immediately actuated by the motions of the diaphragm should be, and practically is given a considerable mass, in which case it is much more difficult to break the contact of the electrodes than if the second or anvil electrode has a less mass, while the variations in the pressure between the two electrodes, which are essential in the operation of such a transmitter, will be much greater, other things being the same, than if the anvil-electrode were lighter.

The reason of this is as follows: The electrode which is attached to, or in contact with the diaphragm, the hammer-electrode, as I will call it, presses more or less lightly against the anvil-electrode under the normal adjustment of the instrument when the instrument is not in operation. On speaking against the diaphragm, motion is first communicated to the hammer-electrode. As this moves forward, it of course tends to set the anvil-electrode in motion.

The larger the mass of the anvil-electrode the more slowly can any given velocity be imparted to it, and hence there will be an increased pressure between the two electrodes which, other things remaining the same, will be greater with a heavier anvil-electrode

than with a lighter one. Similar actions occur in other portions of the vibration of the hammer-electrode. The mechanical resistance to rapid change of velocity in the anvil-electrode may be called "inertia resistance."

This same inertia of the anvil-electrode which prevents its acquiring rapidly the full velocity of the hammer-electrode also tends to prevent its moving away from the latter and so breaking the contact.

Int. 17. Please examine Mr. Dolbear's seventy-sixth cross-answer, page 405, which gives the weights concerning the anvil-electrode in Exhibit Dolbear Transmitter; his answer to Cross-Int. 155, page 430, which gives the corresponding weights in the Reis transmitter; Mr. Buck's 13th cross-answer, page 483, which gives it in the carbon microphone used in some of the defendants' experiments of June 2d; and using your own knowledge of the weight of the anvil-electrode in the Blake transmitter, and of the structure, form and arrangement of the anvil-electrodes in these several instruments, state approximately in terms of weight what you have termed the "inertia resistance" of the anvil-electrodes in these several instruments.

Ans. I have used the term "inertia resistance" to indicate the mechanical resistance which occurs when one moving body exerts pressure upon another, thus tending to increase the velocity of the latter. If the second body acquires a simple motion of translation, or a motion which is practically a simple motion of translation, other things remaining the same, the resistance to change of motion will be immediately dependent upon its mass, and may consequently be measured by its weight.

If the motion impressed upon the second body is partly or wholly a motion of rotation (as in the case of a bar pivoted at one end and moved by the application of a force at the other end), the distribution of the mass of the body, as well as the amount of the mass itself, is influential in determining that resistance. It is evident that in any case the resistance to motion at any moment of a mass which must move with a rotary motion will be equal to the resistance which some determinable mass would offer when acted upon by the same moving force, and that the weight of such a mass may be used to measure this resistance. It is to such a mass, as measured by its weight, that I apply the term "inertia resistance."

In the Blake transmitter the weight of the anvil-electrode is seventy-five grains, and as the motions of the different portions of the electrode are so nearly identical, this will represent very closely its inertia resistance.

In the pendulum carbon microphone used in the experiments of June 2, the weight of the electrode, as in the case of the Blake transmitter, and for the same reason, very closely represents its inertia resistance. This weight is 367.7 grains.

In the Reis transmitter the weight of the hopping piece is sixteen and two tenths grains, and its pressure against the lower electrode

eight and five tenths grains. The inertia resistance is, perhaps, ten grains.

In the case of the Dolbear transmitting apparatus, the weight of the electrode is four hundred and sixty-five grains, and the pressure between the electrodes, fifty-seven grains. The shape of the electrode with its heavy horizontal bar at the end of two supporting pins, which themselves are quite long, gives it a very considerable inertia resistance, which is from seventy-five to one hundred grains.

Of course the effect of this bar is not to add sensibly to the pressure between the electrodes, since it rests directly over the supporting pins, and unless it tilts slightly to one side, it does not affect the pressure between the electrodes at all.

Since, however, this bar is at some distance above the points of support, about which it rotates when set in motion by the hammer electrode, the resistance to motion or inertia resistance is very considerable in proportion to the pressure between the two electrodes.

The inertia resistance of these several instruments can be stated approximately as follows: —

Reis, say, ten grains.

Blake, say, seventy-five grains.

Dolbear transmitter, say, seventy-five to one hundred grains.

The pendulum microphone, say,

Int. 18. Please state whether it is or is not the practice with instruments composed of a diaphragm and free anvil-electrode, which are intended to produce in the current articulating undulations without interruptions, to construct the anvil-electrode with such weight and form as to give to it a notable inertia resistance.

Ans. It is the universal practice to do this.

[*Noon recess.*]

Int. 19. Referring now to the physical structure of the *Reis receiver*, is it an instrument which is calculated to give forth fairly audible sounds under variations of current which are exceedingly delicate as compared with current interruption produced in a circuit of moderate resistance and containing one or two cells of battery?

Ans. The Reis receiver produces, and is adapted to produce, only very feeble sounds when the current passing through it has its strength simply varied without actually breaking the circuit.

Int. 20. In the tests which the defendants made on May 31 and June 2, by applying to the Reis receiver what were, or what they claimed to be, undulatory currents as distinguished from intermittent currents, the listener applied the receiver closely to his ear. Do you find in the Reis publications any direction that it should be so applied, or any statement that it was so applied?

Ans. I find no such direction or statement in any publications referred to.

Int. 21. In Prof. Dolbear's deposition, answer 39, page 384, he states that the Reis receiver was an instrument made "to sit upon a

table like an ordinary telegraph instrument, as if Reis expected that the sounds produced by it might be loud enough to be heard by a room full of people." Does that statement substantially conform to the statements in the Reis publications, both the earlier and the later ones?

Ans. It does.

Int. 22. When the Reis receiver is placed upon a table and actuated by a Reis transmitter operated to break the circuit, with a frequency corresponding to the pitch of the sound actuating it, will such receiver produce a sound loud enough to be heard by the bystanders?

Ans. It will.

Int. 23. When laid upon the table and connected with a Reis transmitter, operated so gently as not to interrupt the circuit, will the receiver produce sounds loud enough to be heard by the bystanders?

Ans. It will not.

Int. 24. Assuming that the Reis transmitter, as a structure, is to-day capable of producing to some extent electrical undulations similar in form to the sound waves, in the hands of those who have learned what was taught by Mr. Bell's patent and by the subsequent invention of the articulating microphone transmitter, will you state whether you find in any of the Reis publications any statement that it was desirable to produce such undulations, as distinguished from interruptions, as the means for transmitting speech or other sounds.

Ans. I find no such statement in any of the Reis publications?

Int. 25. Tell me whether you find, in any of those publications, any statement that electrical undulations similar in form to the actuating sound waves *could* be produced by the Reis transmitter.

Ans. I find no such statement whatever.

Int. 26. Do you find in any of the publications made by Reis, himself, anything which shows that he understood that difference in "form" between vibrations which gives to each sound its quality, as you have explained in your first affidavit?

Ans. I do not find in any of Reis's papers any statement showing that he understood the nature of musical quality.

He apparently had only the indefinite ideas which were popularly current when he wrote.

Int. 27. There have been put in evidence extracts from the catalogues of J. W. Albert, the mechanician, who at Frankfurt a / M., manufactured and sold for Reis his telephone apparatus. One of these catalogues is for 1866 and the other for 1873. Each of them in connection with the telephone of Reis refers to certain books. Will you tell me what those books are, and whether the references are to passages that have been put in evidence?

Ans. The references in the catalogue of 1866 are to Müller-

Pouillet's "Text-book of Physics," sixth edition, Figs. 325–327, and to Pisko's new acoustic apparatus, Fig. 60.

The references in the catalogue of 1873 are to Müller-Pouillet, seventh edition, Figs. 348–350, and to Pisko, Fig. 60.

The passages as referred to in the catalogue of 1873 have been put in evidence in this case. The catalogue of 1866 refers to the same passage in Pisko, and apparently to the same passage in Müller-Pouillet.

Int. 28. When sounds of varying pitches within a moderate range of pitch are sung into the mouthpiece of the Reis transmitter so that it operates to interrupt the currents with a frequency corresponding to the pitch, as stated in the Reis publications, is there or is there not any difficulty in hearing sounds of a corresponding pitch in the Reis receiver connected therewith?

[*Objected to* [*by counsel for defendants in the Dolbear case*] *because it is physically impossible to operate the Reis transmitter in the manner supposed in the question.*]

Ans. There is not.

Int. 29. Did you attend the tests of the Reis exhibits, which the defendants made on May 31 and June 2 last week, and which are reported in Mr. Dolbear's deposition, pages 434–439 and 449–473.

Ans. I did.

Int. 30. Near the close of the test, on May 31, notes of various pitches were sung into the mouthpiece of the transmitter, and were plainly heard, and the differences of pitch recognized by the listener. Do you remember that particular experiment?

Ans. I do; it is stated on pages 438, 439, *supra*.

Int. 31. Did you, while that particular experiment was going on, carefully watch the electrodes of the transmitter; and if so, what facts did you observe showing that the battery current was or was not interrupted?

Ans. I watched the electrodes of the transmitter very carefully while this experiment was in progress, and noticed a continuous series of sparks while the notes were sung, showing, evidently, that the instrument was operating as a circuit-breaker.

Int. 32. I have asked you from the reports of those tests introduced in Prof. Dolbear's deposition, aided by your own notes and recollection, to prepare a brief memorandum of what was accomplished during the attempts which the defendants made to transmit articulate speech with the Exhibit Reis Transmitter and the two Exhibits Reis Receiver No. 1 and Reis Receiver No. 2, which the defendants made May 31 and June 2. If you have done so, will you please read it as a part of your answer?

Ans. I have done so, and it is as follows: —

The result with *Reis transmitter* and *Reis receiver* No. 1 on May 31 was as follows: —

The test occupied twenty-five minutes. Mr. Buck spoke into the Reis transmitter, and Prof. Dolbear listened at the Reis receiver.

Many familiar phrases and many newspaper sentences were spoken; regular numbers, one to five and one to ten, were counted; irregular numbers were counted.

The regular series was repeated thirty times; Prof. Dolbear heard them twice.

"How do you get that?" was repeated fourteen times; Prof. Dolbear heard it twice.

Prof. Dolbear heard, "Mary had a little lamb," three times, and "Mary had a little" once. At the time when he thought he heard these words, no such phrase was uttered into the transmitter. This phrase had been spoken before, and was evidently a familiar one. This is all that was heard during the twenty-five minutes.

During the early part of the experiment the speaking was against the top of the transmitter. This is more likely to produce articulating currents without breaks than speaking into the mouthpiece is, and I think it was during this time that the only phrase and words heard correctly were transmitted. The Reis publications direct that the sounds should be made into the mouthpiece which is provided for that purpose.

Nearly all the speaking was done with a remarkably even and gentle voice, much below the loudness of ordinary conversation. Such force of voice as is used in ordinary conversation, if the mouth be applied to the mouthpiece, invariably caused breaks, manifested to one watching the transmitter by the well-known circuit-breaking sparks and rattling of the contact pieces.

Upon sounding into the mouthpiece sustained notes of different pitches, the circuit-breaking sparks were observed, and the different pitches plainly heard at the receiver.

The result on June 2 was as follows: —

Mr. Buck listened at *Reis receiver No.* 1; Mr. Eaton spoke to the *Reis transmitter*. The voice of the speaker was carefully modulated and gentle, below the tone of ordinary conversation, as on the previous day.

The experiment with *Reis transmitter*, coupled with *Reis receiver No.* 1, lasted eight minutes. Mr. Buck heard as follows: —

"Hallo," which was spoken.

"1, 2, 3, 4, 5," which was spoken.

"Mr. Buck," which was spoken.

"3, 4, 6," which was *not* spoken.

"1, 2, 3, 4, which was spoken three times.

"Transmitter" (he thought); it was *not* spoken.

"Hallo," which was *not* spoken at this time.

With *Reis transmitter*, coupled with *Reis receiver No.* 2, the experiments lasted ten minutes. Mr. Buck heard as follows: —

"1, 2, 3, 4, 5," saying that he wasn't sure of it.

This series was spoken several times.

"Boston," "Boston," remarking "I almost hear; it breaks just enough to spoil it."

"Did you hear that?" it was *not* spoken.

During this last test the voice was more varied; seldom, however, as loud as in ordinary conversation.

Int. 33. I have asked you to prepare in a similar manner a memorandum of what was accomplished on June 2 by the defendants in their attempts to transmit articulate speech with Exhibit Reis transmitter and the two magneto receivers, No. 9 and No. 10.

Ans. I have done, and it is as follows: —

Reis Transmitter and Magneto Receiver No. 9.

Mr. Eaton speaking to transmitter; Mr. Buck listening at receiver.

Time, 10.50–10.54. Mr. Buck thought he heard twenty words. Of these the phrase "Do you understand what I say?" was not spoken. 10.55–11.07. Part of what Mr. Buck said he heard was not spoken. Of a long newspaper paragraph, Mr. Buck repeated one word, "Mr. Bradlaugh," and said that he "could hear occasionally a word." 11.02½–11.04½. Newspaper paragraph of one hundred and ninety-two words read. Mr. Buck heard correctly detached phrases containing sixteen words, and one phrase of three words, "on every hand," which was not spoken.

Reis Transmitter and Magneto Receiver No. 10.

Operators as before.

Time, 11.10–11.13. Mr. Buck heard as follows: "Hallo, Mr. Buck!" numbers 1 to 10 and "Do you get that all right?" heard correctly. Newspaper paragraph of one hundred and seventy-nine words read. Mr. Buck heard three only.

Same instruments; Mr. Buck transmitting and Mr. Eaton receiving.

During eighteen minutes the only result was as follows: —

11.17–11.35. Several familiar phrases, such as "How do you get that?" "Mary had a little lamb," etc., and regular numbers, 1 to 10, heard correctly.

Mr. Buck then picked out from the newspaper detached phrases of four to six words each, repeating them two to six times each; Mr. Eaton heard some of these correctly. Mr. Buck read some newspaper sentences, of which Mr. Eaton heard only detached words.

The foregoing was all spoken to the top of the transmitter, except one or two phrases.

Int. 34. I have asked you to prepare a similar memorandum as to their attempt to transmit speech with the Reis transmitter arranged in the primary circuit of an induction coil, and the ordinary

magneto receiver of the commercial form, connected in the secondary circuit.

Ans. I have done so, and it is as follows: —

The *Reis transmitter* was arranged in the primary circuit of an *induction coil*, and the ordinary *Bell magneto receiver* of the commercial form, connected in the secondary circuit.

Time, 11.39 to 11.45. Counting, ordinary phrases and some newspaper sentences were uttered into the transmitter.

Some clauses, one complete sentence, and one familiar phrase were heard.

Int. 35. I have asked you to prepare a similar memorandum as to their attempts on June 2 to transmit speech with the ordinary carbon microphone and Reis receivers No. 1 and No. 2.

Ans. I have done so, and it is as follows: —

Next experiment. A very powerful *modern carbon microphone* of Mr. Berliner's pendulum pattern was connected in *direct* circuit with *Reis receiver No. 2*. Mr. Eaton spoke into it quite loud and Mr. Buck listened.

Detached phrases spoken into it and repeated three times were heard with substantial correctness.

Same *transmitter* and *Reis receiver No. 1*. Experiment conducted in the same way, with substantially the same result.

I afterwards tested this transmitter with the ordinary commercial Bell magneto receiver. The volume of tone furnished by this transmitter was so great that the words could be understood when the Bell receiver was held a foot away from the ear, though the quality of the tone was rather poor, as is often the case with loud-speaking transmitters.

Int. 36. Have you ever yourself attempted to transmit speech with a pair of instruments substantially like defendants' Exhibit Reis Transmitter and defendants' Exhibits Reis Receiver No. 1 and No. 2? And if so, state whether the results you obtained were substantially the same as or substantially different from the results obtained by the defendants in the tests of May 31 and June 2.

Ans. I have made such attempts with substantially the same results as those obtained by the defendants in the experiments under consideration. I have sometimes guessed out familiar or expected sentences largely by their rhythm, and sometimes I have imagined that I heard and understood sentences which, on inquiry, I found to be totally different from those spoken into the transmitter. I have never heard an unexpected and unfamiliar sentence transmitted by the instruments.

Int. 37. The defendants' Exhibit Reis-Legat Receiver has, among other deviations from the description in Legat's article, a piece of paper pasted over the pole of each magnet near the armature, and a soft bit of soft rubber placed between one of the poles and the armature. Will you tell me whether that addition is of any value, and if

so, what, in an attempt to operate that instrument by feeble electric undulations and thereby produce speech?

Ans. The addition referred to is of great value, since it enables one to bring the armature much closer to the poles of the electro-magnet without danger of its sticking to them in the case of accidental contact between the armature and the poles.

Int. 38. Would "sticking" interfere with the operation?

Ans. It would, since the armature would not be free to vibrate as it is intended to do.

Int. 39. Is it desirable or important to bring the armature very close to the magnet when the instrument is to be actuated by slight variations of current as distinguished from interruption of current?

Ans. It is very desirable to do this when varying, but not intermittent, currents are used, since the effect of such a varying current upon the armature is greater in proportion as it is nearer to the poles of the magnet.

Int. 40. In his deposition, and particularly in page 358, Prof. Dolbear calls attention to the fact that in his receiver the pull between the flexible diaphragm next the ear and the substantially rigid plate or mass behind it varies inversely as the square of the distance. Will you tell me whether or not in the apparatus Fig. 7 of Mr. Bell's patent of March 7, 1876, the pull between the flexible diaphragm and its attached armature on the one hand, and the substantially rigid core of the electro-magnet on the other, does or does not vary inversely as the square of the distance, when the distance is varied?

Ans. Since the armature of the Bell telephone, as shown in Fig. 7 of the patent referred to, is permanently polarized through its connection with the core of the electro-magnet, the attraction between the armature and this core will vary in the inverse ratio of the square of the distance.

Int. 41. On the same page, Mr. Dolbear refers to the fact that, under theoretical circumstances, the pull between the flexible plate of his receiver and the rigid mass behind it varies as the square of the electro-motive force, and not directly as the electro-motive force. Will you state whether the same law is true of the pull between the diaphragm and its attached armature on the one hand and the electro-magnet on the other, in Mr. Bell's apparatus of Fig. 7?

Ans. The same is true in the receiver of Mr. Bell, as shown in Fig. 7.

Int. 42. To avoid any misapprehension, I will ask you whether, in the various attempts by you or in your presence to transmit articulate sounds by the Reis transmitter and receivers, the operators sought to use the Reis transmitter, and so far as they attained any success at all, did use it so as to preserve a contact between the two electrodes, and thereby produce electrical undulations similar in form to the sound waves such as are described in Mr. Bell's patent, or

whether they sought to use and did use it to produce breaks of contact and interruptions of current, as described in the Reis publications?

Ans. The transmitter was so used as to produce electrical undulations without breaking the circuit, as far as possible.

Cross Examination by J. E. MAYNADIER, Esq., *of Counsel for Defendants in the Dolbear case.*

Cross-Int. 43. In the great majority of all telephones now in use there is a very short battery circuit with an instrument in it sometimes called a microphone transmitter, and sometimes called a Blake transmitter, and sometimes called a battery transmitter. What, in your opinion, are the substantial differences between such a transmitter and Exhibit Reis Transmitter? Please name all that you believe to be substantial.

Ans. The Blake transmitter has a metallic diaphragm; the Reis instrument has a membrane diaphragm. The Blake transmitter has a narrow space in front of the diaphragm, between it and the mouthpiece; the Reis transmitter has a long speaking tube, and a cubical box between it and the membrane. The Blake transmitter has a heavy anvil electrode; the Reis apparatus a very light anvil electrode. The Blake is also furnished with an induction coil, though this is not essential; the Reis has no such induction coil.

In the Blake the rear face of the diaphragm and the electrodes are protected from disturbance due to extraneous vibrations by being completely closed within a box; in the Exhibit Reis Transmitter, these electrodes are open to the air, although from the appearance of the instrument there may have been a glass cover placed over the electrodes.

The Blake transmitter is arranged so that the voice of the speaker acts directly upon the membrane without the intervention of any long speaking tube; in the Reis instrument the speaking tube is several inches long.

Cross-Int. 44. Do you not agree with me that the community is indebted to Reis for the initial step now used in the great majority of all telephonic apparatuses now in use, namely, the control of an electric current by the energy of air waves acting upon a diaphragm, which diaphragm acts immediately upon one electrode, through which the current passes, and through that electrode acts upon another electrode, through which the current also passes; and don't you also agree with me that Reis's invention of that method and apparatus is of equal rank, at least, with anything ever accomplished since, in the way of transforming the energy of sound waves into electric energy? If not, please explain why not.

[*Objected to because it is ambiguous in its most important clause,*

and because it mis-states the work and method of Reis as defined by himself and associates.]

Ans. The apparatus of Reis was certainly a very beautiful toy; but in view of the facts that his apparatus was barren of all useful results so far as the transmission of speech is concerned; that it is absolutely impossible to transmit speech by the method that he pointed out; that the electric current is not controlled by the energy of the air waves acting upon his diaphragm; that the first electrode acts upon the second electrode in such a manner as to intermittently and for short periods prevent the currents from passing through any portion of the apparatus; and recollecting, also, that previous to the time of Reis, musical sounds had been reproduced with the apparatus which he uses as a receiver, it does not seem to me that the community is indebted to him for the initial step used in the majority of telephone transmitters now in use. Both his transmitter and receiver are absolutely abandoned, and a mode of operation of which he had not the slightest conception is the only one which is or ever can be utilized for the transmission of speech. All that Reis really did, it seems to me, was to substitute a circuit-breaker operated by the voice for a circuit-breaker operated in other ways. He evidently hoped to do very much more, but the more he extended his experiments, so far as is shown by anything that has been published, the less sanguine did his hopes or the beliefs of others become.

The method by which he expected to transmit the voice being an impossible one, his idea of using that method is valueless in the transmission of speech. Finally, in reference to the last few clauses of your question, Reis never transformed the energy of sound waves into electrical energy. He simply caused the circuit to be periodically broken, because of the energy of sound waves. In such a case as this, the energy of the sound waves is no more transformed into electrical energy than is the energy of the finger which pulls the trigger of a gun transformed into the energy due to the exploding powder; or the energy of the arm which opens a floodgate transformed into the energy of the stream which is let loose, or the energy of the hand that plants a seed transformed into the energy stored up in the tree that grows from it.

[*Adjourned.*]

BOSTON, June 8, 1883.

Cross-Int. 45. Please look at the instrument now shown you [*now put in evidence, and marked "Defendants' Exhibit Reis Transmitter, First Form, W. A. C., Special Examiner"*], and state how it differs, if at all, from that form first described by Reis and others.

[*The exhibit and the name given to it objected to on the ground that it is totally different from anything described by Reis or others in the publications put in evidence, and is the direct opposite of the apparatus described by Reis in his lecture of October, 1861, in those*

particulars in which the production of an undulatory current as distinguished from an intermittent current depends.

[*In view of the objection of the complainants' counsel, the defendants' counsel adds to the questions the following:*] I refer you particularly to the report of Reis's lecture of 1861, and the cut therein contained.

Ans. Setting aside minor differences, I find this very important one. Speaking of the operation of his instrument, Reis says: —

"If now tones or tone combinations are produced in the neighborhood of the block, so that sufficiently powerful waves reach the opening *a*, then these sounds cause the membrane *b* to vibrate.

"At the first condensation the hammer-like wire *d* is pushed back; at the rarefaction it cannot follow the retreating membrane, and the current traversing the strip remains broken, until the membrane, forced by a new condensation, again presses the strip (proceeding from *p*) against *d*. In this way each sound wave causes a breaking and closing of the current." (See the Lecture, pp. 541, 542, *infra*.)

It appears from this statement that the construction of the hammer-like wire *d* is such that when the membrane moves away from it under the influence of a rarefied sound wave the wire *cannot* follow the membrane, so that the current is broken until the next condensation presses the strip that is attached to the membrane against this hammer-like wire. In the exhibit apparatus now produced and referred to in your question, the arrangement of the electrodes is totally different

The hammer-like wire is attached to the end of a brass spring which presses this wire against the second electrode, bearing upon it in such a way that it tends to follow and can follow the retreating membrane to a very considerable extent, thus preventing the circuit from being broken if the person speaking into the instrument uses a low or moderate tone of voice, thus bringing about simple variations in pressure at the contact point of the two electrodes without necessarily producing a rupture of contact.

Cross-Int. 46. You don't consider, then, that the thin strip of metal which carries the electrode *d* in Reis's cut is a metal spring?

Ans. My understanding of the apparatus is, that the thin strip of metal which extends from the binding screw *n* to a point over the middle of the membrane, there terminating in the platinum wire *d*, is not a flexible strip pressing the wire *d* into contact with the other electrode so that the wire *d* can follow this electrode in its retreating motion, but a stiffer strip or a strip so set that it does not tend to follow the membrane as it recedes.

Cross-Int. 47. But you do believe that the strip from the binding post *p* is a light metal spring, do you not?

Ans. The strip connected with *p* must be of such a nature as to allow the membrane to vibrate, and therefore is, I suppose, thin.

Cross-Int. 48. I suppose you meant to answer my last question

in the affirmative by implication from the word "thin." Does not the same implication clearly apply to the thin strip from the binding screw *n*?

Ans. I do not know that the metal strip referred to in the forty-sixth question is necessarily a spring. All that the lecture says regarding the metal is, that there is a conducting strip of platinum cemented to the middle of the membrane and which is in connection with the binding screw *p*. Regarding the wire which is attached to the binding screw *n*, all that is said is, that there is likewise a thin strip of metal which extends as far as the middle of the membrane, ending there in a platinum wire.

Cross-Int. 49. Don't you think it very likely that the strip from the post *n* is substantially the same as the corresponding strip in the Exhibit Reis Transmitter, first form?

[*Complainants object to substituting anybody's guesses for the written description published by Reis himself.*]

Ans. I have nothing beyond Reis's statements by which I can form any opinion upon this matter. I am very certain that if any one were constructing apparatus to act in the manner in which Reis states as a matter of fact that his apparatus did act, he would not make the apparatus with a metal spring as shown in your Exhibit Reis Transmitter, First Form, but would arrange the platinum wire so that it could not follow the retreating membrane, and the most natural mode of doing this would be to use a heavier or much stiffer strip of metal.

Cross-Int. 50. You mean, do you not, that he would make the piece of metal from binding post *n*, as Dr. Van der Weyde described it in his article, namely, not a "*thin strip* of metal," but a plate or bar substantially rigid, holding the electrode *d* away from contact with the electrode carried by the tympan when the tympan is not in vibration?

[*Complainants object that the question mis-states the description by Dr. Van der Weyde.*]

Ans. He would certainly not use a piece of metal too thin to perform the function which Reis explicitly states was performed by the thin strips of metal referred to. It does not follow from this, it seems to me, that he would use a plate or bar. All that he would have to do would be to use a strip of metal which for convenience' sake he would probably make thin rather than thick, and which he would not mount in such a way as absolutely to defeat the object which, in his copy of the Reis apparatus, he intended to secure.

Cross-Int. 51. Considering now the later form of Reis transmitter (Exhibit Reis Transmitter), have you any doubt that the tympan of transmitters of that kind were, as a matter of fact, actuated by the energy of sound waves from vocal and other sounds, so as to produce in the circuit what it is now become common to call the "undulatory current," by which I mean variations in the strength of a voltaic cur-

rent similar in form to the vibrations of the air accompanying the vocal and other sounds acting upon the tympan of the transmitter, and that such variations of current strength were always produced in every such transmitter ever coupled up in an electric circuit, and will be in all others that ever shall be so coupled up?

Ans. Your question is so broad in its references to the Reis apparatus that I find it somewhat difficult to answer it. It is certainly highly probable that accidentally and without their being recognizable, undulatory currents have been produced. I have seen no evidence to show that they were ever produced intentionally prior to the date of Mr. Bell's patent. As to whether any Reis transmitter ever has been or ever can be fitted up without the production of undulatory currents to a certain extent, all that I can say is, that when the apparatus was not in use for transmitting sounds, such currents would very possibly be formed by the vibration of the membrane by extraneous noises, and even when the pitch of sounds was transmitted by the apparatus during the brief periods of contact of the electrodes, some such electrical undulations may have been produced. Of this, however, I am certain, that if produced at all, they were produced accidentally and unintentionally without any one's being aware of their existence, knowing how to produce them, or ever having conceived of the idea of producing and utilizing them; so that they were, at most, mere waste products.

[*Adjourned.*]

BOSTON, June 9, 1883.

Cross-Int. 52. You are aware, I suppose, that Exhibit Reis Transmitter, when its diaphragm is submitted to a large class of vocal and other sounds, will cause electrical undulations in the battery current similar in form to the air vibrations accompanying sounds of that class; and when subjected to another class of sounds will cause a peculiar intermittent current which is very similar to the air vibrations accompanying such sounds to a certain extent, but not sufficiently so for practical use in the transmission of speech, because of the fact that the current is not only interrupted, but at brief intervals actually ceases; the two classes of sound I have in mind are (those last referred to) all vocal and other sounds of an intensity sufficient to break the contact between the electrodes of the Reis transmitter and (those first referred to) all vocal and other sounds of an intensity insufficient to do that.

Ans. If the Exhibit Reis Transmitter is so operated that the method of Mr. Bell and not that of Reis is used, that is, if the electrodes instead of parting contact with each other as the diaphragm vibrates to and fro, remain in contact and so rest upon each other with a variable pressure, then electrical undulations will be produced. If, on the other hand, the method of Reis is used, such undulations will not be produced. The clause in your question which refers to the interruption and cessation of the current is

utterly unintelligible to me, since the term "interruption of a current" has in electricity one meaning and one meaning only, that is, the breaking of the current.

Cross-Int. 53. I will repeat my question in a different form of words. You are aware, are you not, that the Reis transmitter is, under certain conditions as to intensity or loudness of sound, adapted for use under what you call the Bell method?

Ans. It is possible, with the Reis transmitter, to produce electrical undulations similar in form to the sound waves producing them.

Cross-Int. 54. And by electrical undulations, etc., in your answer, you mean precisely "electrical undulations similar in form to the vibrations of the air accompanying the" sound waves acting upon the tympan of the transmitter, do you not?

Ans. I do.

Cross-Int. 55. You are also aware, are you not, that the Reis receiver of the knitting-needle pattern will give out audible speech when actuated by currents of proper strength and form?

Ans. It is possible, as the defendants' experts have shown in this case, by using a very powerful modern microphone transmitter, to produce electrical undulations so powerful that with the knitting-needle receiver they will produce audible speech,

Cross-Int. 56. I don't think your answer is as responsive as it should be. Please answer the question again.

Ans. I do not understand in what respect my answer fails to respond to the question asked. If by "currents of proper strength and form" is meant currents which will cause the knitting-needle receiver to produce audible speech, my answer will of course be in the affirmative.

. . . . . .

Int. 133. State whether you do or do not find in any of the publications which have been put in evidence any indication that the various writers, or the persons whose ideas they profess to report, sought to produce, or conceived that it was desirable to produce, by any means or in any part of their respective instruments, electrical undulations similar in form to the sound waves constituting the sound sought to be transmitted, or even electrical undulations of any form as distinguished from electrical intermittences.

Ans. I do not find in any of the publications referred to any indication whatever that it was supposed by any one that it was desirable to produce electrical undulations rather than electrical intermittences, still less that it was desirable to produce electrical undulations similar in form to the sound waves constituting the sound to be transmitted.

Int. 134. What kind of variations do those publications show that the writers and experimenters directed their care to the production of and believed they had produced?

Ans. Intermittences.

Int. 135. In the attempts which you have made to transmit speech by the Reis apparatus, what care did you take to secure favorable conditions, and what success did you have? State how much you ever transmitted with it.

Ans. I have several times tried to transmit speech by means of the Reis apparatus. In the last and most successful experiments which I made, I took every precaution that I could think of to secure success. The transmitter and receiver were in separate rooms in the same building, the receiver was in a room which was absolutely quiet, the receiving and transmitting rooms were connected together by a telltale line furnished with speaking telephones. The time chosen was a holiday and the building was closed. No one was in the rooms except those taking part in the experiments, and absolute quiet was secured.

Anything which I thought that I heard with the Reis apparatus was transmitted by the telltale line to the transmitting room, and the words which were actually spoken into the Reis transmitter were transmitted to me through the telltale line. The speaker at the transmitting end was a person accustomed to the use of all kinds of telephonic apparatus, with whose voice I was perfectly familiar. He was requested to speak with as great loudness as was consistent with a preservation of the unbroken contact between the electrodes of the transmitter, and from time to time he was communicated with through the telltale line, that he might speak louder, or less loud, as the experiment seemed to require. I listened very carefully at the receiving instrument, and several times thought that I understood short sentences which were transmitted, but found on inquiry through the telltale line that I was mistaken. The only sentence which I heard correctly was one which had invariably been used by the same speaker in testing different kinds of telephones with me, and which I could recognize even by its rhythm. The sentence was, "The sun is shining brightly," which was actually the case at the time.

I was at the time that it came, conscious that its rhythm as much as anything else enabled me to recognize it. I also recognized the clause, "It is half-past ——" The sentence spoken into the transmitter being, "It is half-past five."

This was also a sentence which it was customary for the speaker to use with me as a listener in testing telephones, and here again the rhythm was a sufficient indication of the sentence to enable me to recognize all except the last word. This was all I succeeded in recognizing, although the experiment lasted about an hour. In my experience in testing telephones, — the efficiency of telephone transmitters and receivers, — I have not felt at liberty to rely on the recognition of familiar and frequently repeated sentences, since it is easy to

recognize such sentences from rhythm alone, although there is no proper articulation.

Int. 136. Will you state how nearly the Reis apparatus used by you on this occasion resembled defendant's Exhibits Reis Transmitter and Reis Receiver No. 1, particularly as regards size of diaphragm, and material and weight of hopping piece of the transmitter?

Ans. The Reis apparatus used by me was as perfect a reproduction as possible of the defendants' Exhibits Reis Transmitter and Reis Receiver No. 1. The only differences that I could find were that the reproduced receiver did not have some of the cracks which were present in the Exhibit Receiver, and that the wood of which the apparatus was made was of a different material.

. . . . . .

Int. 138. In several of the Reis publications the peculiar tone or sound produced at the Reis receiver is noticed. Thus Pisko states (record, page 586): —

"Its strength not very remarkable, and its clang [quality] buzzing, like that of a weak-sounding reed-pipe, something like a child's trumpet."

Kuhn, record, page 598, says: —

"The quality of the sounds thus produced is not pleasant. They are almost like the sounds of toy trumpets at times, also like the buzz of a fly caught in a spider's web, and the like."

Dr. Van de Weyde, page 609, says: —

"The receiving instrument in fact sings the melodies transmitted, as it were, with its own voice, resembling the humming of an insect, regardless of the quality of the tone which produces the original tune at the other end of the wire."

Will you state whether in using the Reis apparatus you have observed this characteristic buzzing sound at the receiver, and whether it is due to a circuit-breaking action or to a michrophonic action ofthe transmitter?

Ans. I have frequently noticed the buzzing sound, which is very marked and peculiar, resembling almost exactly the buzzing of a fly, and it is produced only when the transmitter is so operated as to make and break the circuit.

The quality of sounds transmitted microphonically is quite different. I have tried the experiment of having the person at the Reis transmitter sing a single prolonged note into it, at first very gently, so as not to break the circuit, then more loudly, so that the circuit was broken at each vibration of the membrane. I could always tell the moment at which microphonic transmission of the sound ceased, and transmission of the pitch alone by the action of the transmitter as a circuit-breaker began, by the sudden change of the quality of the sound heard at the receiver, this peculiar buzzing quality appearing immediately upon the beginning of the breaking of the circuit by the transmitter.

Int. 139. In that experiment could you tell by the relative loudness of the sounds when the microphonic action ceased and the circuit-breaking began, and how marked was the difference?

Ans. The loudness of the sound is far greater when the circuit is broken than when the sound is transmitted microphonically. In the latter case I could only hear the sound by placing my ear closely against the receiving instrument, whereas, in the former case, the sounds produced by the receiver were loud enough to be distinctly audible throughout a very large room.

Int. 140. In your fifty-first cross-answer, page 508, you have stated that while the circuit is being made and broken at each vibration of the membrane, some slight electrical undulations might possibly be produced during the brief instant when the electrodes were in contact between two successive interruptions. Will you state whether such fragmentary interruptions which can thus be produced would give an effective undulatory character to the current, as a whole, or whether they would be overshadowed and their possible theoretical effects overpowered by intervening interruptions?

Ans. The interruptions are so frequent and the sound due to them so loud that the minute effects referred to in my fifty-first answer would be entirely overpowered, and it would be practically impossible for them to give any undulatory character to the current as a whole. Whatever minute undulations might be produced would be entirely devoid of practical value, even if they could be observed at all.

Int. 141. Were circuit-breakers (by which I mean devices which absolutely broke off the current and then let it flow again while alternately opening and closing the circuit) known to and in use by electricians in 1860; and if so, will you state whether the phrase used in the German publications relating to Reis, to characterize his apparatus and the operations which he performed, was the same as that technically applied to other circuit-breakers?

Ans. Circuit-breakers were constantly employed by electricians at the date mentioned. The phrase by which the apparatus and operation of the Reis transmitter are designated are the same as those technically applied to other forms of circuit-breaker; thus, in the Reis lecture as published by Reis, on page 542, I find among others the following expressions, of which I give both the English and the German: "In this way each sound wave causes a breaking and closing [ein Oeffnen und ein Schliessen] of the current [Stromes]. . . . On breaking the circuit [beim emterbrechen des Stromes] these atoms seek to regain their position of equilibrium. . . . This is the case if the making and breaking of the current [Unterbrechungen und Schliessungen des Stromes] occur with comparative slowness." . . .

"The iron wire no longer gives its longitudinal (normal) tone, but a tone whose pitch corresponds to the number of interruptions [Unterbrechungen] (in a given time); this is the same as saying

that *the rod reproduces the tone [ton] impressed upon the interrupter [dem Unterbrechungs apparat].*"

In Kuhn's description of Reis, page 393 of the record, the term "Unterbrecher" is applied to a well-known form of circuit-breaker: "Yet the possibility cannot be controverted that the principle of Neef's circuit-breaker [Unterbrecher] might contribute to the solution of the problem in question."

On page 594 the same term is repeated.

In Müller-Pouillet's description of Reis, page 603 of the record, I find an ordinary circuit-breaker is denominated by the same term (Unterbrechungs apparat) that is applied a few lines below to the Reis transmitter.

The term "unterbrechung" is the ordinary term technically used to indicate the breaking of the circuit, and the term "unterbrecher" or "unterbrechungs-apparat" is a technical designation of a circuit-breaker. It never has any other meaning than this.

Int. 142. Is the book of Kuhn, which you have just referred to, a standard work of recognized authority or not?

Ans. It is a standard work, and was the best work in German upon the subjects of which it treats at the date of its publication, in 1866."

Int. 5. As those instruments were more particularly described by Prof. Dolbear's assistant, Mr. Buck, in his deposition in that case, will you please read therefrom his answers 4 to 7, inclusive?

Ans. I will; they are as follows: —

"Extract from Deposition of Henry C. Buck, a witness called for the defendants in Dolbear's case.

Int. 4. Please state what experience you have had in the use of these three instruments, Exhibits Reis Transmitter, Reis Receiver No. 1 and Reis Receiver No. 2, with the transmitter and one of the receivers in the same circuit; and state, also, how otherwise you have used these exhibits and with what results.

Ans. I myself bought in Europe, of the man who said he made them, the above-mentioned transmitter and receiver No. 1, in 1881. They were in exact imitation of those now held by the German government, and which were claimed to have been an original pair of instruments constructed for Reis. I myself compared these instruments with those original instruments which were exhibited at the International Electrical Exhibition at Paris, in 1881, and found no appreciable difference. I have frequently experimented with those instruments, and also with receiver No. 2. The greater part of my experiments with these instruments were performed in the laboratory at Tufts College, that place being selected because compara-

tively free from noise, and the time was selected when noise was least likely to interfere with our experiments.

To produce the best and most satisfactory effects, favorable conditions are essential.

I have frequently connected the Reis transmitter above mentioned, in a direct circuit with one of the two receivers, and have, perhaps invariably, been able to hear counting and single words, and occasionally whole sentences, although this is a delicate experiment, and requires absolute freedom from all disturbing influences.

My experiments with these instruments have been varied in a great many ways, and have included many complex combinations, extending over a period of several years.

From these experiments I will briefly describe two or three. I have connected up this Reis transmitter with various receiving telephones in direct circuit, as, for example, a low resistance magneto-receiver. Under these conditions, if the person at the transmitter spoke in a voice of suitable strength, I was able to understand distinctly many sentences, and sometimes have been able to hear and understand nearly, if not all, that was said at the transmitter, thus showing that the Reis transmitter is capable of producing an undulatory current. To produce these results it is desirable that the listener should have means of constantly communicating with the person who is transmitting.

I have also frequently connected these Reis receivers, No. 1 and No. 2, in direct circuit with any good modern carbon transmitter, and been able to hear, while listening at the receiver, nearly, if not quite all that was said at the transmitter, this experiment going to show that the Reis receiver is capable of receiving. In this answer I have not referred to the tests which were made in the presence of the examiner and parties, because I did not understand that the question calls for it.

[*Adjourned.*]

BOSTON, June 4, 1883.

Int. 5. In your last answer you say that it is desirable that the listener should have means of constantly communicating with the person who is transmitting. Please explain more fully what you mean by that, and why it is desirable.

Ans. It has been my experience with the several Reis transmitters which I have used — I mean like Exhibit Reis Transmitter in all respects — that each instrument differs from the others in the loudness of tones to which it should be subjected for the best results; also the pitch, there is a certain pitch best adapted to each instrument. The Reis transmitters will not transmit properly when coupled in direct circuit, unless precautions be taken to maintain a suitable loudness and pitch in the voice of the person transmitting. This is why it is desirable for the listener to be able to give such necessary

directions to the person transmitting as to varying the loudness and pitch when producing the best results.

Int. 6. Did you take part in the tests, May 31 and June 2, of the Reis receivers and the Reis transmitter in direct circuit, with Prof. Dolbear and Mr. Eaton? If so, please explain the main difficulties under which those tests were carried on.

Ans. I did. As I said in the previous answer, it is quite desirable, in experiments with these instruments, that they be performed in a place free from all extraneous noises, both in the room and from the street. While listening at the receiver, during those experiments, there were several persons in the room at all times, some of whom were engaged in writing; and consequently, more or less noise was produced. Moreover, the noise from the street was found to be quite a serious inconvenience while listening at the receiver, although the room may be regarded as in a quiet locality.

In a previous answer I also stated that it is essential that the proper degree of loudness of tone and pitch of the voice be maintained by the speaker while using the Exhibit Reis Transmitter. In all my previous experiments we have had means provided for giving such necessary directions to the persons at the transmitter. During the experiments we were not allowed to have direct communication. If I observed while listening at the receiver that the sounds were either too strong or too weak, it was necessary for me to request Mr. Chauncey Smith, who was provided with the telltale line telephone, to inform Mr. Storrow to tell the speaker to speak a little stronger or a little weaker, as the case might be. It generally happened when this was done that the speaker took the other extreme, and the elaborate process had to be repeated. If I simply remarked while listening at the receiver that the speaker was speaking too loud or too weak, no attention was given to the remark by Mr. Smith.

Moreover, when I found by listening at the receiver that the conditions were nearly right for producing a sentence, I often hesitated to make request for a change, because thinking the conditions would the next moment come all right without my interference. I also frequently omitted to report the minor words, lest by so doing the sound produced by my voice should prevent my hearing a complete sentence.

Int. 7. Please state the best results which you personally have obtained with Exhibit Reis Transmitter in direct circuit with Reis receiver No. 1 as compared with the result of the tests last week when those two instruments were used together.

Ans. When I first experimented with Reis receiver No. 1 it was in much better condition than it was during those experiments of last week, since the sounding boards have become cracked and broken in several places. My former experience with receiver No.

1 and No. 2 compared, was that No. 1 receiver produced much clearer tones, but that receiver No. 2 was the louder instrument.

I have heard longer sentences, louder talking and more distinct enunciation with receiver No. 1 during former experiments than I heard during those of last week. This I take to have been partly due to the poorer condition of the receiver during these experiments of last week, and partly to the conditions being much less favorable at those times.

[*Defendants here put in evidence the two magneto receivers referred to in the reports of the experiments of June 2 as Nos. 9 and 10, and they are marked "Exhibits Magneto 9 and Magneto 10, W. A. C., Special Examiner."*]"

CHAS. R. CROSS.

Sworn and subscribed to before me this second day of October, 1885.

FRED. M. OTT, *Special Examiner.*

(Complainants put in evidence: —

A copy of its decree and the opinion in the Spencer case.

A copy of the pleadings and decree in the case of the American Bell Telephone Company *et al. v.* Ashael K. Eaton *et al.*

A copy of the testimony for Gray in the speaking telephone interferences.

Article entitled "The Carbon Telephone," from the *Scientific American*, June 8, 1878.

A lecture entitled "Connection between Sound and Electricity," by Mr. William H. Preece, delivered at London, May 23, 1878, printed in the Journal of the Society of Telegraphic Engineers, vol. 2, p. 270.

An article entitled "The Microphone Relay," by Profs. Houston and Thomson, from the *Telegraphical Journal and Electrical Review*, for Aug. 15, 1878, vol. 6, pages 343, 345.

Decision of Commissioner of Patents, March 3, 1885, in the Speaking Telephone Interferences.

Decision of the Board of Examiners in Chief, Oct. 4, 1884, in the same matter.)

[*Adjourned until Oct. 3, 1885, at 10 A. M.*]

DEPOSITION OF ARTHUR W. WRIGHT.

OCT. 3, 1885, 10 A. M.

Present: Mr. STORROW, *for Complainants.*

ARTHUR W. WRIGHT, being produced, sworn and examined, saith: —

Examined by Mr. STORROW.

I am forty-nine years of age; professor of molecular physics in Yale College, and reside at New Haven, Conn.

Int. 1. Have you given special attention to the subject of electric speaking telephones in their various forms, including microphones?

Ans. I have been familiar with the subject from its beginning, having witnessed some of the earliest public experiments by Prof. Bell, and having been familiar with the subject, both theoretically and experimentally ever since.

Int. 2. In a deposition by Prof. Cross, put into this case by defendants, he has described a number of experiments made in the Ghegan case; also some experiments made with the double contact Blake apparatus more recently. Will you state whether you performed those experiments, or most of them, with Prof. Cross, and also in your own laboratory at New Haven?

Ans. I did; and I paid special attention to the experiments for the determination of the variation of the contact resistance of conducting substances under slight variations of pressure. I made a series of several hundred experiments of this kind.

Int. 3. Will you state whether you agree with the statements and conclusions made by Prof. Cross with regard to those experiments?

Ans. I do entirely agree with him.

Int. 4. Were you present in Philadelphia on Feb. 6, 1885, at some telephone tests made by the defendants, and about which Prof. Barker has testified?

Ans. I was present at those experiments.

Int. 5. Were you in the transmitting room, or in the receiving room, or both?

Ans. I was in the transmitting room during the greater portion

of the experiments, but went into the receiving room and remained there a short time near the close of the afternoon.

Int. 6. Did you listen at the receiver at any time?

Ans. I did not.

Int. 7. How were the tumbler transmitters used on that occasion supported while speech was being transmitted?

Ans. They were held by the person speaking, usually with both hands close to the mouth, and inclined at an angle of forty to forty-five degrees, I should say.

Int. 8. Did you then and there, after the instruments had been used, examine the carbon powders in them; and if so, what was the physical character of those powders?

Ans. The instruments were taken apart after the conclusion of the tests with them, so that their construction could be freely examined. The powder which they contained appeared to be pulverized carbon of a degree of fineness such as would enable it to pass through the meshes of a sieve of from forty to fifty to the inch, in my estimation. It was granular in appearance, and gritty to the touch, somewhat like rather coarse sand. The powder in one of the transmitters was somewhat finer than that in the other, and something appearing like bronze powder had been added to it; otherwise it was very similar to that in the other.

Int. 9. Have you since then attempted to transmit speech electrically by means of an apparatus composed of a tumbler transmitter substantially like the so-called "F reproduced," and a tin-can receiver substantially like "B reproduced," using granular carbon powder in the cup of the tumbler transmitter, and having that instrument held in an inclined position? If so, state whether you were able to so transmit intelligible articulate speech.

Ans. I have tried this experiment, and have been able to transmit speech very well.

Int. 10. What effect was produced by simply placing the tumbler transmitter on the table, with the diaphragm and carbon holding cup in a horizontal position, without changing any of the other conditions, if you tried that?

Ans. I did; when the transmitter was placed in this position, the first few words which were spoken to it were heard at the re-

ceiver fairly well, but the sound soon became confused and the articulation indistinct, this effect increasing until no words at all could be recognized. The sound took on a harsh and irregular character, and sometimes suddenly ceased altogether. All after the first few words were so indistinct as to be unintelligible.

Int. 11. After articulation had thus been lost by placing the instrument in a horizontal position, what effect was produced by again taking the instrument in the hand and tipping it up?

Ans. The effect of this change was to restore the articulation of the instrument, and render the speech transmitted perfectly clear and intelligible.

ARTHUR W. WRIGHT.

Subscribed and sworn to before me, this third day of October, 1885.

FRED. M. OTT, *Special Examiner.*

[*At the request of the defendants, the taking of testimony is adjourned to Monday, Oct.* 5, 1885, *at* 10 A. M., *and Prof. Wright, Prof. Cross and Mr. Pope will be recalled for cross examination, if desired.*]

OCT. 5, 1885.

Present: Mr. STORROW, *for Complainants; and*
Mr. MELVILLE CHURCH, *for Respondents.*

By consent, adjourned until Oct. 6, 1885, *at* 10.30 A. M.

OCT. 6, 1885, 10.30 A. M.

Present: Mr. STORROW, *for Complainants, and*
Mr. J. B. CHURCH *and* Mr. MELVILLE CHURCH, *for Respondents.*

Prof. Cross and Mr. Pope cross-examined, after which adjourned until Oct. 7, *at* 10 A. M.

OCT. 7, 1885, 10 A. M.

Present: Mr. STORROW, *for Complainants; and*
Messrs. J. B. CHURCH *and* MELVILLE CHURCH, *for Respondents.*

Cross examination of Professor Arthur Wright waived by counsel for respondents, upon all matters relating to the Drawbaugh issue.

Mr. Keasbey having requested extension of time upon other matter, complainants state that they will produce Professor Wright and Professor Cross for cross-examination, at room 37, No. 40 State Street, Boston, Mass., Oct. 14, 1885, at 10 A. M., unless the parties shall agree upon some other place. On condition, however, that this postponement shall not prevent any of the cases in which this deposition is to be used from being put upon the trial list for the term next after to-day.

Subject to such right, and what complainants may think necessary in consequence of any such cross examination, the complainants close their reply.

The following is the notice, pursuant to which the foregoing testimony has been taken: —

"CIRCUIT COURT OF THE UNITED STATES,

SOUTHERN DISTRICT OF NEW YORK.

AMERICAN BELL TELEPHONE COMPANY ET AL.
v.
THE OVERLAND TELEPHONE COMPANY ET AL. } In Equity.

CIRCUIT COURT OF THE UNITED STATES.

DISTRICT OF NEW JERSEY.

THE AMERICAN BELL TELEPHONE COMPANY
v.
THE OVERLAND TELEPHONE COMPANY, OF NEW JERSEY ET AL. } In Equity.

CIRCUIT COURT OF THE UNITED STATES,

EASTERN DISTRICT OF PENNSYLVANIA.

AMERICAN BELL TELEPHONE COMPANY ET AL.
v.
PENN. OVERLAND TELEPHONE AND TELEGRAPH COMPANY ET AL. } In Equity.

To A. Q. KEASBEY, Esq.,
Defendants' Solicitor:

SIR: Please take notice that on Friday, October 2, next, at the offices of J. J. Storrow, room 37, 40 State Street, Boston, before Charles H. Swan, Esq., Special Examiner, or some other competent officer, the complainants will take testimony in reply.

You are invited to attend and cross-examine.

DICKERSON & DICKERSON,
Solicitors for Complainants.

NEW YORK, Sept. 19, 1885.

Due service acknowledged.

A. Q. KEASBEY,
Counsel for Defendants.

BOSTON, MASS., Oct. 7, 1885.

I hereby certify that the foregoing depositions of witnesses in the three cases of the American Bell Telephone Company *et al. v.* The Overland Telephone Company *et al.*, in the United States Circuit Courts for the Southern District of New York, the District of New Jersey and the Eastern District of Pennsylvania, respectively, were taken before me, and that the said witnesses were respectively sworn by me, and signed their depositions in my presence at the times and at the place set forth in the foregoing record; also, that all papers put in evidence were left in my custody at the times set forth.

FRED. M. OTT,
Special Examiner.

NEW YORK, Oct. 15, 1885, 11 A. M.

Examination resumed by consent.

Present: Messrs. DICKERSON and STORROW, *for Complainants;*
A. Q. KEASBEY, Esq., *for Defendants.*

The counsel for the defendants, in pursuance of an arrangement made before the taking of the foregoing testimony in Boston, now objects to the admission of the following matters put in on the part of the complainants, namely,

The certified copies from the Post-Office Department concerning J. M. Boyle, consisting of the report of the Post-Office Inspector

and the Assistant Attorney General, and the order of the Postmaster General, referred to on page 193, and printed on pages 617 to 633 inclusive.

Defendants' counsel also objects to the admission of the Decision of the Commissioner of Patents, March 3, 1885, in the Speaking Telephone Interferences; and the Decision of the Board of Examiners in Chief, Oct. 4, 1884, in the same matter, put in evidence by the complainants, page 217 of their printed record—on the ground that such legal decisions are not competent evidence.

Testimony closed.

United States Circuit Court.

THE AMERICAN BELL TELEPHONE COMPANY ET AL.

v.

THE OVERLAND TELEPHONE COMPANY ET AL.

REPORT OF PROCEEDINGS DURING THE TESTING OF TELEPHONES IN ROOM NO. 28, WASHINGTON HOTEL, PHILADELPHIA, PA., FEB. 6, 1885, AT 3 P. M.

Report by Stenographer employed by Complainants.

Complainants' counsel requests the respondents' counsel to take off the electro-magnet of instrument of B form, and show it.

Respondents' counsel declines to do so, on the ground that he does not want the instruments interfered with until after the test, at which time they can be examined by complainants' counsel.

Complainants' counsel requests the respondents' counsel to open the instrument of the I [F] form, and show the interior of it before beginning the test.

Respondents' counsel replies that he will not allow any of the instruments to be interfered with prior to the test, but after the test they can be examined by complainants' counsel and experts if they wish to inspect them. More than that, complainants' counsel does not wish any meddling with the instruments until after that.

Report in Receiving Room.

Prof. Barker states that the instrument he is about to listen at is marked "B_2," and is the one to which he has referred by that designation.

Prof. Barker listening at the tin-can receiver; Mr. Marx, Sen., speaking into the telltale line.

Mr. STORROW. 3.13 o'clock.

Mr. MARX, Sen. (at telltale). No, I don't hear you. You had better adjust the instrument.

[*Prof. Barker was requested to go into the other room and look at the transmitter, and immediately returned.*]

Mr. STORROW. 3.15 o'clock.

Mr. MARX, Sen. (at the telltale). All right. (*To Prof. Barker.*) They want us to hold on a moment. Professor, they are ready now. Yes. What is it? Are you ready now? Are you going to begin? What say?

Mr. STORROW. 3.17 o'clock.

(*Mr. Marx, Sen., here went into the other room, and upon returning said:*) You try and adjust it, please. He wants to adjust it. You tell me what sounds you get over it. (At telltale.) We are ready.

Prof. BARKER (at receiver). "Professor, do you hear me now? Is it adjusted right?"

Mr. MARX, Sen. (at telltale). "Professor, do you hear me now? Is it adjusted right?"

Prof. BARKER. Tell him it is a little loose and not very loud.

Mr. MARX, Sen. (at telltale). "It is a little loose and not very loud." All right.

Mr. STORROW. 3.19 o'clock.

Prof. BARKER. No better.

Mr. MARX, Sen. (at telltale). "No better." It is a little loose and not loud. (*To stenographer.*) You needn't put down that, I say.

THE STENOGRAPHER OF THE OVERLAND COMPANY. All right. I understand.

Mr. STORROW (*to Bell Telephone Company stenographer*). Take down everything.

Mr. MARX, Sen. (at telltale). What is it? No. I guess not. I guess not.

Mr. STORROW. 3 20 o'clock.

Prof. BARKER. Not as good as before, tell him.

Mr. MARX, Sen. (at telltale). "Not as good as before."

Prof. BARKER. A little better.

Mr. MARX, Sen. (at telltale). "A little better."

Prof. BARKER (at receiver). "Professor, how is it now, please?"

Mr. MARX, Sen. (at telltale). "Professor, how is it now, please?"

Prof. BARKER. Tell him it is better all the time.

Mr. MARX, Sen. (at telltale). "It is better all the time."

Prof. BARKER (at receiver). "Well, well, how is it now?"

Mr. MARX, Sen. (at telltale). "Well, how is it now?"

Prof. BARKER. No better.

Mr. MARX, Sen. (at telltale). "No better."

Prof. BARKER (at receiver). "One, two, three, four, five, six."

Mr. MARX, Sen. (at telltale). "One, two, three, four, five, six."

Prof. BARKER. Tell him to adjust a little tighter.

Mr. MARX, Sen. (at telltale). "Adjust a little tighter."

Prof. BARKER. Too loose.

Mr. MARX, Sen. (at telltale). "Too loose."

Prof. BARKER. Rattles.

Mr. MARX, Sen. (at telltale). "It rattles."

Prof. BARKER. It is better. A little more.

Mr. MARX, Sen. (at telltale). "It is better. A little more."

Prof. BARKER. It is becoming better all the time.

Mr. MARX, Sen. (at the telltale). "It is becoming better all the time."

Mr. STORROW. 3.22 o'clock.

Prof. BARKER (at receiver). "Now I have changed it again." It is better now. It is very good now.

Mr. MARX, Sen. (at telltale). "Now I have changed it again." "It is better now; it is very good now."

Prof. BARKER (at receiver). "We are now in room 29, Washington Hotel."

Mr. MARX, Sen. (at telltale). "We are now in room 29, Washington Hotel."

Prof. BARKER (at receiver). "I think now I will let Judge Hill take the instrument." All right.

Mr. MARX, Sen. (at telltale). "I think now I will let Judge Hill take the instrument." "All right." Ready? Yes.

Mr. STORROW. 3.23 o'clock.

Prof. BARKER (at receiver). "Hello! I hardly know what to say."

Mr. MARX, Sen. (at telltale). "Hello! no, I don't know what to say."

Prof. BARKER (*correcting*). "I hardly know what to say."

Mr. MARX, Sen. (at telltale). "I hardly know what to say."

Mr. STORROW. 3.25 o'clock.

Mr. MARX, Sen. (at telltale). We are ready.

Prof. BARKER (at receiver). "There are a number of insulated wires against the wall."

Mr. STORROW. 3.26 o'clock.

Mr. MARX, Sen. (at the telltale). "There are a number of insulated wires against the wall."

Prof. BARKER (at the receiver). "There are three beds in this room."

Mr. MARX, Sen. (at telltale). "There are three beds in this room."

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Mr. STORROW. 3.27 o'clock.

Prof. BARKER (at receiver). "There are two shorthand writers in this room."

Mr. MARX, Sen. (at telltale). "There are two shorthand writers in this room."

Prof. BARKER (at receiver). "Mr. Dickerson has just sat down."

Mr. MARX, Sen. (at telltale). "Mr. Dickerson has just sat down."

Prof. BARKER (at receiver). "Mr. Jacobs—"

Mr. MARX, Sen. (at telltale). "Mr. Jacobs—"

Prof. BARKER (at receiver). "is walking on the floor of this room."

Mr. MARX, Sen (at the telltale). "is walking on the floor of this room."

Mr. STORROW. 3.28 o'clock.

Prof. BARKER (at receiver). "And Mr. Dennis Marx is standing near the door."

Mr. MARX, Sen. (at telltale). "And Mr. Ernest Marx is standing near the door."

[*Some conversation here occurred as to whether it was Dennis or Ernest Marx, and the following occurred:* —]

Prof. BARKER. You must not be talking when I am listening.

Mr. MARX, Sen. You said Ernest?

Prof. BARKER. I understood it Dennis. Repeat that.

Mr. MARX, Sen. (at telltale). "Repeat that."

Prof. BARKER (at receiver). "Mr. Coates is sitting on the lounge."

Mr. MARX, Sen. Mr. who?

Mr. STORROW. 3.29 o'clock.

Prof. BARKER (at receiver). "Coach."

Mr. MARX, Sen. (at telltale). "Mr. Coach is sitting on the lounge."

Prof. BARKER (*aside*). I suppose it must be "Pope." Repeat, not quite so loud.

Mr. MARX, Sen. (at telltale). "Repeat not quite so loud."

Prof. BARKER (at receiver). "There is a table before me which I am resting upon."

Mr. MARX, Sen. (at telltale). "There is a table before me which I am resting upon."

Mr. STORROW. 3.30 o'clock.

Prof. BARKER (at receiver). "There is a telephone cord lying on this table."

Mr. MARX, Sen. (at telltale). "There is a telephone cord lying on this table."

Prof. BARKER. Telephone cord, yes.

Mr. MARX, Sen. (at telltale). "Telephone cord, yes."

Prof. BARKER (at receiver). "It is a very pleasant day."

Mr. MARX, Sen. (at telltale). "It is a very pleasant day."

Prof. BARKER (at receiver). "Washington is one hundred and forty miles from Philadelphia."

Mr. MARX, Sen. (at telltale). Washington is one hundred and forty miles from Philadelphia."

Prof. BARKER (at receiver). "The Atlantic Ocean is 3000 miles wide."

Mr. STORROW. 3.31 o'clock.

Mr. MARX, Sen. (at telltale). "The Atlantic Ocean is 3000 miles wide."

Prof. BARKER (at receiver). "Boston is the capital of Massachusetts."

Mr. MARX, Sen. (at telltale). "Boston is the capital of Massachusetts."

Prof. BARKER (at receiver). "Now, I think I will allow Mr. Hill to take the transmitter."

Mr. MARX, Sen. (at telltale). "Now, I think I will allow Mr. Hill to take the transmitter."

Prof. BARKER. Tell him all right. It comes very well.

Mr. STORROW. 3.32 o'clock.

Mr. MARX, Sen. (at telltale). "All right; it comes very well." It comes all right over here. Ready.

Prof. BARKER (at receiver). "Professor Barker, do you hear me now?" Yes, I hear him very well. Tell him to talk slow.

Mr. MARX, Sen. (at telltale). "Professor Barker, do you hear me now?" The professor says he hears you well. Talk slow.

Prof. BARKER (at receiver). "Do you distinguish the difference between my voice and that of Mr. Drawbaugh." Yes, perfectly.

Mr. MARX, Sen. (at telltale). "Do you distinguish the difference between my voice and that of Mr. Drawbaugh?" "Yes, perfectly." (*Repeating.*) Do you distinguish between my voice—"

Prof. BARKER (*correcting*). "The difference between."

Mr. STORROW. 3.33 o'clock.

Mr. MARX, Sen. (at telltale). "the difference between my voice and that of Mr. Drawbaugh?" "Yes, perfectly."

Prof. BARKER (at the receiver). "How is the articulation of this instrument now?"

Mr. MARX, Sen. (at the telltale). "How is the articulation of th[illegible] instrument now?"

Prof. BARKER. Very good.

Mr. MARX, Sen. (at telltale). "Very good."

Prof. BARKER (at receiver). "How plainly can you hear what I say?"

Mr. MARX, Sen. (at telltale). "How plainly can you hear what I say?"

Prof. BARKER. Perfectly.

Mr. MARX, Sen. (at telltale). "Perfectly."

Mr. STORROW. 3.34 o'clock.

Prof. BARKER (at receiver). "When did you leave the University to-day?"

Mr. MARX, Sen. (at telltale). "When did you leave the University to-day?"

Prof. BARKER. At quarter of two.

Mr. MARX, Sen. (at telltale). "Quarter of two."

Prof. BARKER (at receiver). "Did you deliver a lecture before you left?"

Mr. MARX, Sen. (at telltale). "Did you deliver a lecture before you left?"

Prof. BARKER. Yes.

Mr. MARX, Sen. (at telltale). "Yes."

Prof. BARKER (at receiver). "How many students had you present at your lecture?"

Mr. MARX, Sen. (at telltale). "How many students had you present at your lecture?"

Prof. BARKER. Between eighty and ninety.

Mr. MARX, Sen. (at telltale). "Between eighty and ninety."

[*At this point Mr. Marx, Jr., took the telltale instrument.*]

Mr. STORROW. 3.35 o'clock.

Prof. BARKER (at the receiver). "What was the subject of the lecture?"

Mr. MARX, Jr. (at the telltale). "What was the subject of the lecture?"

Prof. BARKER. Polarization.

Mr. MARX, Jr. (at the telltale). "Polarization." What is that? "Polarization." "Polarization."

Mr. STORROW. You will ruin the character of your other instrument, if you don't look out.

Mr. MARX, Jr. (at telltale). What do you say? "Polarization." What? Oh, all right. (*To Prof. Barker.*) He wants me to give him more time. Are you ready? "Po-lar-i-za-tion."

Prof. BARKER. You had better use this for a telltale, then.

Mr. MARX, Jr. I guess he don't know what the word is, any way. It scared him, I suppose.

Prof. BARKER. It seems to have struck them all standing, don't it?

Mr. STORROW. If you make too many remarks in this, you will get them all mixed up in the report. If you say too many things that you don't hear through there, they will all get mixed up in the report. "Polarization" did not come from the other end.

Prof. BARKER. The question is whether I am to answer his questions.

Mr. STORROW. No, I don't think you had better. Just repeat what you hear.

Prof. BARKER. Very well.

Mr. MARKS, Jr. (at telltale). All right; go ahead.

Prof. BARKER (at receiver). "Now, professor, do you hear me?"

Mr. MARX, Jr. (at telltale). "Now, professor, do you hear me?"

Mr. STORROW. 3.37 o'clock.

Prof. BARKER (at receiver). "Your lecture was on polarization, was it?"

Mr. MARX, Jr. (at telltale). "Your lecture was on polarization, was it?"

Prof. BARKER (at receiver). "I should like to have been present and heard it."

Mr. MARX, Jr. (at telltale). "I should like to have been present and heard it."

Prof. BARKER (at receiver). "Was it on the polarization of light?"

Mr. MARX, Jr. (at telltale). "Was it on the polarization of light?"

Prof. BARKER (at receiver). "Can you tell me who discovered the polarization of light and its cause?"

Mr. STORROW. 3.39 o'clock.

Mr. MARX, Jr. (at telltale). "Can you tell me who discovered the polarization of light and its cause?"

Prof. BARKER. "This suit will be tried before Judge McKennan and Judge Butler."

Mr. MARX, Jr. (at telltale). "This suit will be tried before Judge McKennan and Judge Butler."

Mr. STORROW. 3.40 o'clock.

Prof. BARKER (at receiver). "Mr. Drawbaugh is now sitting near the bed in this room."

Mr. MARX, Jr. (at telltale). "Mr. Drawbaugh is now sitting near the bed in this room."

Prof. BARKER (at receiver). "Did you illustrate your lecture by any experiments on the polarzation of light?"

Mr. MARX, Jr. (at telltale). "Did you illustrate your lecture by any experiments on the polarization of light?"

Prof. BARKER (at receiver). "Chestnut Street is one of the finest streets in Philadelphia."

Mr. MARX, Jr. (at telltale). "Chestnut Street is one of the finest streets in Philadelphia."

Prof. BARKER (at receiver). "Does this instrument still hold its adjustment well?"

Mr. MARX, Jr. (at telltale). "Does this instrument still hold its adjustment well?"

Prof. BARKER (at receiver). "Mr. Storrow is in your room now, is he not?"

Mr. MARX, Jr. (at telltale). "Mr. Storrow is in your room now, is he not?"

Mr. STORROW. 3.42 o'clock.

Prof. BARKER (at receiver). "Prof. Cross is there with him, is he not?"

Mr. MARX, Jr. (at telltale). "Prof. Cross is there with him, is he not?"

Prof. BARKER (at receiver). "And there is a stenographer present in the room on the part of the Bell Company, is there not?"

Mr. MARX, Jr. (at telltale). "And there is a stenographer present in the room on the part of the Bell Company, is there not?"

Mr. STORROW. 3.43 o'clock.

Prof. BARKER (at receiver). "It is said that Gen. Gordon has either been captured or killed."

Mr. MARX, Jr. (at telltale). "It is said that Gen. Gordon has either been captured or killed."

Prof. BARKER (at receiver). "who addressed the people from the balcony."

Mr. MARX, Jr. (at telltale). "who addressed the people from the balcony."

Mr. STORROW. 3.50 o'clock.

Prof. BARKER (at receiver). "After the speaking — "

Mr. MARX, Jr. (at telltale). "After the speaking — "

Prof. BARKER (at receiver). "the ladies were driven around the city, — "

Mr. MARX, Jr. (at telltale). "the ladies were driven around the city, — "

Prof. BARKER (at receiver). "and the gentlemen proceeded to the hall of the House of Representatives — "

Mr. MARX, Jr. (at telltale). "and the gentlemen proceeded to the hall of the House of Representatives, — "

Prof. BARKER (at receiver). "where a reception was held, — "

Mr. MARX, Jr. (at telltale). "where a reception was held, — "

Prof. BARKER (at receiver). "and several hundred persons — "

Mr. MARX, Jr. (at telltale). "and several hundred persons — "

Prof. BARKER (at receiver). "were presented to the Vice-President elect."

Mr. MARX (at telltale). "were presented to the Vice-President elect."

Prof. BARKER (at receiver). "The party left for Birmingham — "

Mr. MARX, Jr. (at telltale). "The party left for Birmingham — "

Prof. BARKER (at receiver). "at ten o'clock — "

Mr. MARX (at telltale). "at ten o'clock — "

Prof. BARKER (at receiver). and will proceed from there — "

Mr. MARX (at telltale). "and will proceed from there — "

Prof. BARKER (at receiver). "to the New Orleans Exposition"

Mr. MARX, Jr. (at telltale). "to the New Orleans Exposition."

Mr. STORROW. 3.52 o'clock.

Prof. BARKER. (at receiver). "Much enthusiasm — "

Mr. MARX, Jr. (at telltale). "Much enthusiasm — "

Prof. BARKER (at receiver). "was manifested over Mr. Hendricks."

Mr. MARX, Jr. (at telltale). "was manifested over Mr. Hendricks."

Prof. BARKER (at receiver). "That is the end of the article."

Mr. MARX, Jr. (at telltale). "That is the end of the article."

Prof. BARKER (at receiver). "What receiver have you now on the line at your end?"

Mr. MARX, Jr. (at telltale). "What receiver have you now on the line at your end?"

Prof. BARKER. B_2, tell him.

Mr. MARX, Jr. (at telltale). "B_2."

Mr. STORROW. 3.53 o'clock.

Mr. MARX, Jr. (at telltale). No, A but B. "B_2." "B_2." Hello! The second letter of the alphabet and the second number of the numerals. "B_2."

Prof. BARKER. That is worse than polarization. (At receiver.) "You say you have receiver B_2. Is that correct?" It is.

Mr. STORROW. 3.54 o'clock.

Mr. MARX, Jr. (at the telltale). "You say you have receiver B_2. Is that correct?" "It is."

Prof. BARKER (at receiver). "All right. I will now remove this instrument, F_2."

Mr. MARX, Jr. (at telltale). "All right. I will now remove this instrument, F_2."

Prof. BARKER (at receiver). "No, I have changed my mind; I will not remove it."

Mr. MARX, Jr. (at telltale). "No, I have changed my mind; I will not remove it."

Mr. STORROW. 3.55 o'clock.

Prof. BARKER (at receiver). "But I will ask you to remove your receiver."

Mr. MARX, Jr. (at telltale). "But I will ask you to remove your receiver."

Prof. BARKER (at receiver). "And to substitute one of the receivers of the form known as 'I.'"

Mr. MARX, Jr. (at telltale). "And to substitute one of the receivers of the form known as 'I.'"

Prof. BARKER. I wasn't listening. Please repeat.

Mr. MARX, Jr. (at telltale). "I wasn't listening. Please repeat."

Prof. BARKER (at receiver). "When you have done that, I will resume."

Mr. STORROW. 3.56 o'clock.

Mr. MARX, Jr. (at telltale). "When you have done that, I will resume." What is that? We are changing it now. Hello! Are you ready for work?

Mr. MARX, Sen. Receiver I and F instrument in the other room?

Mr. MARX. Yes. (At telltale). We are ready; go ahead.

Prof. BARKER (at receiver). "Now, Professor Barker, do you hear me?" Yes, very well.

Mr. MARX, Jr. (at telltale). "Now, Professor Barker, do you hear me?" He said, "Yes, very well."

Prof. BARKER (at receiver). "Do you hear me any more plainly than you did on receiver B_2?"

Mr. MARX, Jr. (at telltale). "Do you hear me any more plainly than you did on receiver B_2?"

Prof. BARKER (at receiver). "Please answer back whether you do or do not?"

Mr. MARX, Jr. (at telltale). "Please answer back whether you do or do not."

Prof. BARKER. Answer.

Mr. MARX, Jr. (at telltale). "Answer."

Prof. BARKER. I hear him just as distinctly, and a little louder.

Mr. MARX, Jr. (at telltale). He says he hears you just as distinctly, and a little louder.

Prof. BARKER (at receiver). "Suppose, now, I read you an article from the newspaper."

Mr. MARX, Jr. (at telltale). "Suppose, now, I read you an article from the newspaper."

Prof. BARKER (at the receiver). "Are you ready? Please answer back." Yes; but speak a little lower.

Mr. MARX, Jr. (at the telltale). "Are you ready? Please answer back." Answer, "Yes; but speak a little lower."

Mr. STORROW. 3.59 o'clock. (*To Prof. Barker*) Say, *tell him*, to distinguish in the report.

Prof. BARKER. I have been in the habit of saying, "answer." (*To Mr. Marx, Jr.*) Tell him to repeat. I was not listening.

Mr. MARX, Jr. (at telltale). Hello. "Repeat." We were talking in here, and the professor was not listening.

Prof. BARKER (at the receiver). "I will read another article from this morning's Philadelphia *Press*."

Mr. MARX, Jr. (at telltale). "I will read another article from this morning's Philadelphia *Press*."

Prof. BARKER (at the receiver). "It is entitled 'Party endorsement of General Logan.'"

Mr. MARX, Jr. (at the telltale). "It is entitled 'Party endorsement of General Logan.'"

Mr. STORROW. 4 o'clock.

Prof. BARKER (at the receiver). "And is copied from the New York *Independent*."

Mr. MARX, Jr. (at the telltale). "And is copied from the New York *Independent*."

Prof. BARKER (at the receiver). "It is as follows."

Mr. MARX, Jr. (at the telltale). "It is as follows."

Prof. BARKER (at the receiver). "We sincerely desire the reelection —"

Mr. MARX, Jr. (at the telltale). "We sincerely desire the reelection —"

Prof. BARKER (at the receiver). "to the United States Senate —"

Mr. MARX (at the telltale). "to the United States Senate —"

Prof. BARKER (at the receiver). "of General John A. Logan, of Illinois."

Mr. MARX, Jr. (at the telltale). "of General John A. Logan, of Illinois."

Mr. STORROW. 4.01 o'clock.

Prof. BARKER (at the receiver). "He has been a very useful and true man, —"

Mr. MARX, Jr. (at the telltale). "He has been a very useful and true man, —"

Prof. BARKER (at the receiver). "has done good service to his country — "

Mr. MARX, Jr. (at the telltale). "has done good service to his country — "

Prof. BARKER (at the receiver). "as a soldier, — "

Mr. MARX, Jr. (at the telltale). "as a soldier, — "

Prof. BARKER (at the receiver). "and is greatly respected in Congress."

Mr. MARX, Jr. (at the telltale). "and is greatly respected in Congress."

Prof. BARKER (at the receiver). "He has the entire confidence — "

Mr. STORROW. 4.02 o'clock.

Mr. MARX, Jr. (at the telltale). "He has the entire confidence — "

Prof. BARKER (at the receiver). "of the Republican party —"

Mr. MARX, Jr. (at the telltale). "of the Republican party — "

Prof. BARKER (at the receiver). "and of the people generally, — "

Mr. MARX, Jr. (at the telltale). "and of the people generally, — "

Prof. BARKER (at the receiver). "both in and out of the State, — "

Mr. MARX, Jr. (at the telltale). "both in and out of the State, — "

Prof. BARKER (at the receiver). "whom he now so ably represents."

Mr. MARX, Jr. (at telltale). "whom he now so ably represents."

Prof. BARKER (at the receiver). "*Who* he now so ably represents."

Mr. MARX, Jr. (at telltale). "*Who* he now so ably represents."

Mr. STORROW. 4.03 o'clock.

Prof. BARKER (at the receiver). "No, not *who*, — *he*."

Mr. MARX, Jr. (at telltale). "No, not *who*, — *he*."

Prof. BARKER (at receiver). "He now so ably represents, —"

Mr. MARX, Jr. (at telltale). "He now so ably represents, —"

Prof. BARKER (at receiver). "and he doubtless will have, —"

Mr. MARX, Jr. (at telltale). "and he doubtless will have, —"

Prof. BARKER (at the receiver). "as he deserves to have, —"

Mr. MARX, Jr. (at the telltale). "as he deserves to have, —"

Prof. BARKER (at the receiver). "the solid vote —"

Mr. MARX, Jr. (at the telltale). "the solid vote —"

Prof. BARKER (at the receiver). "of all the Republicans —"

Mr. MARX, Jr. (at the telltale). "of all the Republicans —"

Mr. STORROW. 4.04 o'clock.

Prof. BARKER (at the receiver). "of the Legislature of Illinois —"

Mr. MARX, Jr. (at the telltale). "of the Legislature of Illinois —"

Prof. BARKER (at the receiver). "to secure his return to the Senate."

Mr. MARX, Jr. (at the telltale). "to secure his return to the Senate."

Prof. BARKER (at the receiver). "That is the end of the article, —"

Mr. MARX, Jr. (at the telltale). "That is the end of the article, —"

Prof. BARKER (at the receiver). "and I cordially endorse what it says."

Mr. MARX, Jr. (at the telltale). "and I cordially endorse what it says."

Prof. BARKER (at receiver). "My friend Mr. Drawbaugh would probably take the opposite side."

Mr. MARX, Jr. (at telltale). "My friend Mr. Drawbaugh would probably take the opposite side."

Mr. STORROW. 4.05 o'clock.

Prof. BARKER (at receiver). "Now I will remove instrument F_2 —"

Mr. MARX, Jr. (at telltale). "Now I will remove instrument F_2 —"

Prof. BARKER (at receiver). "and substitute another form of F instrument, —"

Mr. MARX, Jr. (at telltale). "and substitute another form of F instrument, —"

Prof. BARKER (at receiver). "which has a carbon box supported by two rods or wires."

Mr. MARX, Jr. (at telltale). "which has a carbon box supported by two rods or wires."

Mr. STORROW. 4.06 o'clock.

Prof. BARKER (at receiver). "The one I have been using —"

Mr. MARX, Jr. (at telltale). "The one I have been using —"

Prof. BARKER (at receiver). "had the carbon box supported by a single rod."

Mr. MARX, Jr. (at telltale). "had the carbon box supported by a single rod."

Mr. MARX, Sen. Are you ready?

Prof. BARKER. I supposed he was fixing it. I was not listening.

Mr. MARX, Sen. (*to Prof. Barker*). Judge Hill is ready.

Mr. STORROW. What have you got down at the other end?

Mr. MARX, Sen. F with two rods instead of a single rod.

Mr. STORROW. F_3 or F_1?

Mr. MARX, Sen. F_1.

Mr. MARX, Jr. Are you ready?

Prof. BARKER. Yes; we are ready if you are.

Mr. MARX, Jr. (at telltale). "Yes."

Prof. BARKER (at receiver). "Professor, do you hear me?"

Mr. MARX, Jr. (at telltale). "Professor, do you hear me?"

Prof. BARKER (at receiver). "How is the adjustment?"

Mr. MARX, Jr. (at telltale). "How is the adjustment?"

Prof. BARKER. For heaven's sake, tell him don't talk so lou

Mr. MARX, Jr. (at telltale). Don't talk so loud there, Heigi tell him.

Prof. BARKER (at receiver). "How is that?" Answer, better.

Mr. MARX, Jr. (at telltale). "How is that?" "Better." The question was, "How is that?" The answer, "Better."

Mr. STORROW. 4.10 o'clock.

Prof. BARKER (at receiver). "I asked, How is the adjustment?"

Mr. MARX, Jr. (at telltale). "I asked, How is the adjustment?"

Prof. BARKER. Not good, answer.

Mr. MARX, Jr. (at telltale). "Answer, not good."

Prof. BARKER (at receiver). "Is it too loud or too weak?" Answer, too loud.

Mr. MARX, Jr. (at telltale). "Is it too loud or too weak?" "Answer, too loud."

Mr. STORROW. 4.11 o'clock.

Prof. BARKER (at receiver). "I commenced to use it without adjusting it."

Mr. MARX, Jr. (at telltale). "I commenced to use it without adjusting it."

Prof. BARKER (at receiver). "I took it out of the box—"

Mr. MARX, Jr. (at telltale). "I took it out of the box—"

Prof. BARKER (at receiver). "and I hitched it to the line—"

Mr. MARX, Jr. (at telltale). "and I hitched it to the line—"

Prof. BARKER (at receiver). "just as it was,—"

Mr. MARX, Jr. (at telltale). "just as it was,—"

Prof. BARKER (at receiver). "but I will now adjust it a little—"

Mr. MARX, Jr. (at telltale). "but I will now adjust it a little—"

Prof. BARKER (at receiver). "if you think it will work better."

Mr. MARX, Jr. (at telltale). "if you think it will work better.

Prof. BARKER (at receiver). "What do you think about it?" Answer, I think the articulation might be improved.

Mr. MARX, Jr. (at telltale). "What do you think about it?" "Answer, I think the articulation might be improved."

Prof. BARKER (at receiver). "Well, how is this now?" Answer, very weak.

Mr. MARX, Jr. (at telltale). "Well, how is this now?" "Answer, very weak."

Mr. STORROW. 4.13 o'clock.

Prof. BARKER (at receiver). "I have changed it a little. How is it now?"

Mr. MARX, Jr. (at telltale). "I have changed it a little. How is it now?"

Prof. BARKER. Answer, good as to loudness. The articulation is not yet perfect.

Mr. MARX, Jr. (at telltale). "Answer, good as to loudness, but the articulation is not yet perfect."

Prof. BARKER (at receiver). "Perhaps I have spoken a little too loud into it. How is it now?" Answer, better.

Mr. MARX, Jr. (at telltale). "Perhaps I have spoken a little too loud into it. How is it now?" "Answer, better."

Mr. STORROW. 4.14 o'clock.

Prof. BARKER (at receiver). "I spoke too loud, I suppose."

Mr. MARX, Jr. (at telltale). "I spoke too loud, I suppose."

Prof. BARKER (at receiver). "Do you think you could hear a newspaper article now?"

Mr. MARX, Jr. (at telltale). "Do you think you could hear newspaper article now?"

Prof. BARKER. Answer, yes.

Mr. MARX, Jr. (at telltale). "Answer, yes."

Prof. BARKER (at receiver). "I will read something again from this morning's *Press*."

Mr. MARX, Jr. (at telltale). "I will read something again from this morning's *Press*."

Mr. STORROW. 4.15 o'clock.

Prof. BARKER (at receiver). "Washington, Feb. 5."

Mr. MARX, Jr. (at telltale). "Washington, Feb. 5."

Prof. BARKER (at receiver). "There were quite a number of absentees —"

Mr. MARX, Jr. (at telltale). "There were quite a number of absentees —"

Prof. BARKER. Repeat.

Mr. MARX, Jr. (at telltale). "Repeat."

Prof. BARKER (at receiver). "on the Democratic side —"

Mr. MARX, Jr. (at telltale). "on the Democratic side —"

Mr. STORROW. 4.16 o'clock.

Prof. BARKER (at receiver). "of both the House and Senate chambers —"

Mr. MARX, Jr. (at telltale). "of both the House and Senate chambers —"

Prof. BARKER (at receiver). "this morning, —"

Mr. MARX, Jr. (at telltale). "this morning, —"

Prof. BARKER (at receiver). "and the invariable answer was — "

Mr. MARX, Jr. (at telltale). "and the invariable answer was —"

Prof. BARKER (at receiver). "when a senator or representative could not be found, — "

Mr. MARX, Jr. (at telltale). "when a senator or representative could not be found, — "

Prof. BARKER. Repeat.

Mr. MARX, Jr. (at telltale). "Repeat."

Prof. BARKER. Again.

Mr. MARX, Jr. (at telltale). "Again." He wants you to repeat again.

Mr. STORROW. 4.17 o'clock.

Prof. BARKER (at receiver). "'Gone to see Cleveland.'"

Mr. MARX, Jr. (at telltale). "'Gone to see Cleveland.'"

Prof. BARKER (at receiver). "Several of these gentlemen — "

Mr. MARX, Jr. (at telltale). "Several of these gentlemen — "

Prof. BARKER. Repeat.

Mr. MARX, Jr. (at telltale). "Repeat."

Mr. STORROW. 4.18 o'clock.

Prof. BARKER. Repeat a little louder.

Mr. MARX, Jr. (at telltale). "Repeat a little louder."

Prof. BARKER. Tell him, no use. The adjustment is bad.

Mr. MARX, Jr. (at telltale). "No use; the adjustment is bad."

Prof. BARKER. Answer, very weak.

Mr. MARX, Jr. (at telltale). "Very weak."

Prof. BARKER (at receiver). "How is it now?" Answer, better, if you will talk lower.

Mr. MARX, Jr. (at telltale). "How is it now?" "Better, if you will talk lower."

Mr. STORROW. 4.19 o'clock.

Prof. BARKER (at receiver). "Now how is it?" Answer, good, but speak a little lower.

Mr. MARX, Jr. (at telltale). "Now how is it?" "Good, but speak a little lower."

Prof. BARKER (at receiver). "Now I will resume the newspaper article, where I left off. Do you get that?"

Mr. MARX, Jr. (at telltale). "Now I will resume the newspaper article where I left off. Do you get that?"

Prof. BARKER. Answer, yes; but —

Mr. MARX, Jr. (at telltale). "Answer, yes —"

Prof. BARKER (at receiver). "Are you ready?" No, adjust a little closer. Answer, no.

Mr. MARX, Jr. (at telltale). "Are you ready?" "Answer, no; adjust a little closer."

Mr. STORROW. 4.20 o'clock.

Prof. BARKER (at the receiver). "Well, how is it now? Do you get it any plainer?" No, very weak.

Mr. MARX, Jr. (at the telltale). "Well, how is it now? Do you get it any plainer?" "No, very weak."

Prof. BARKER (at the receiver). "How is it now?" Very good.

Mr. MARX, Jr. (at telltale). "How is it now?" "Very good."

Prof. BARKER (at receiver). "Well, is it good now still?" Answer, yes it is.

Mr. MARX. Jr. (at telltale). "Well, it is now good still?" "Answer, yes."

Mr. STORROW. 4.21 o'clock.

Prof. BARKER (at receiver). "Shall I resume the newspaper article now?" Yes.

Mr. MARX, Jr. (at telltale). "Shall I resume the newspaper article now?"

Prof. BARKER. Answer, yea; but talk a little lower."

Mr. MARX, Jr. (at telltale). "Yes, but talk a little lower."

Prof. BARKER (at receiver). "Several of the gentlemen —"

Mr. MARX, Jr. (at telltale). "Several of the gentlemen —"

Prof. BARKER (at receiver). "who have been contemplating visits to the President elect, —"

Mr. MARX, Jr. (at telltale). "who have been contemplating visits to the President elect, —"

Prof. BARKER (at receiver). "upon the public notice that he would be at home —"

Mr. MARX, Jr. (at the telltale). "upon the public notice that he would be at home —"

Mr. STORROW. 4.22 o'clock.

Prof. BARKER (at receiver). "to all persons desiring to talk with him — "

Mr. MARX, Jr. (at the telltale). "to all persons desiring to talk with him — "

Prof. BARKER (at the receiver). "regarding governmental business, — "

Mr. MARX, Jr. (at telltale). "regarding governmental business, — "

Prof. BARKER (at receiver). "were surprised to learn — "

Mr. MARX (at telltale). "were surprised to learn — "

Prof. BARKER (at receiver). "that special invitations — "

Mr. MARX, Jr. (at telltale). "that special invitations — "

Prof. BARKER (at receiver). "had been extended — "

Mr. MARX, Jr. (at telltale). "had been extended — "

Prof. BARKER (at receiver). "to a majority of the senators — "

Mr. MARX, Jr. (at telltale). "to a majority of the senators — "

Mr. STORROW. 4.23 o'clock.

Prof. BARKER (at receiver). "and quite a number of the more prominent representatives."

Mr. MARX, Jr. (at telltale). "and quite a number of the more prominent representatives."

Prof. BARKER (at receiver). "This fact, however, — "

Mr. MARX, Jr. (at telltale). "This fact, however, — "

Prof. BARKER (at receiver). "is intended in no way — "

Mr. MARX, Jr. (at telltale). "is intended in no way — "

Prof. BARKER (at receiver). "to preclude others from calling upon Cleveland."

Mr. MARX, Jr. (at telltale). "to preclude others from calling n Cleveland."

t'rof. BARKER (at receiver). "Those who have had invitations — "

Mr. MARX, Jr. (at telltale). "Those who have had invitations — "

Mr. STORROW. 4.24 o'clock.

Prof. BARKER (at receiver). "understood that their visits — "

Mr. MARX, Jr. (at telltale). "understood that their visits — "

Prof. BARKER (at receiver). "were primarily to make the acquaintance of the President elect, — "

Mr. MARX, Jr. (at telltale). were primarily to make the acquaintance of the President elect, — "

Prof. BARKER (at the receiver). "and to talk with him — "

Mr. MARX, Jr. (at telltale). "and to talk with him — "

Prof. BARKER (at receiver). "and discuss with him — "

Mr. MARX, Jr. (at telltale). "and discuss with him — "

Prof. BARKER (at receiver). "matters of legislative and executive policy, — "

Mr. MARX, Jr. (at telltale). "matters of legislative and executive policy, — "

Mr. STORROW. 4.25 o'clock.

Prof. BARKER (at receiver). "rather than to give advice — "

Mr. MARX (at telltale). "rather than to give advice — "

Prof. BARKER (at receiver). "as to the selection of a cabinet."

Mr. MARX, Jr. (at telltale). "as to the selection of cabinet."

Prof. BARKER (at receiver). "The more prominent visitors, however, — "

Mr. MARX, Jr. (at telltale). "The more prominent visitors, however, — "

Prof BARKER (at the receiver). "will not hesitate to give Mr. Cleveland — "

Mr. MARX, Jr. (at telltale). "will not hesitate to give Mr. Cleveland — "

Prof. BARKER (at receiver). "their views regarding cabinet appointments."

Mr. MARX, Jr. (at telltale). "their views regarding cabinet appointments."

Mr. STORROW. 4.26 o'clock.

Prof. BARKER (at receiver). Right. "*Their* views — "

Mr. MARX, Jr. (at telltale). "*Their* views — "

Prof. BARKER (at receiver). "regarding cabinet appointments,— "

Mr. MARX, Jr. (at telltale). "regarding cabinet appointments, — "

Prof. BARKER (at receiver). Repeat.

Mr. MARX, Jr. (at telltale). "Repeat."

Prof. BARKER (at receiver). "and the friends of Mr. McDonald, —"

Mr. MARX, Jr. (at telltale). "and the friends of Mr. McDonald, —"

Prof. BARKER (at receiver). "Mr. Barbour, —"

Mr. MARX, Jr. (at telltale). "Mr. Barbour, —"

Prof. BARKER. Repeat.

Mr. MARX, Jr. (at telltale). "Repeat."

Prof. BARKER (at receiver). "Mr. Manny, —"

Mr. MARX, Jr. (at telltale). "Mr. Manny, —"

Prof. BARKER (at receiver). "M-a-n-e-y."

Mr. MARX, Jr. (at telltale). "M-a-n-e-y."

Mr. STORROW. 4.27 o'clock.

Prof. BARKER (at receiver). "M-o-n-e-y."

Mr. MARX, Jr. (at telltale). "M-o-n-e-y."

Prof. BARKER (at receiver). "Mr. Money, —"

Mr. MARX, Jr. (at telltale). "Mr. Money, —"

Prof. BARKER (at receiver). "Mr. Hopkins, —"

Mr. MARX, Jr. (at telltale). Mr. Hopkins, —"

Prof. BARKER. Rej eat.

Mr. MARX, Jr. (at telltale). "Repeat."

Prof. BARKER. Again.

Mr. MARX (at telltale). "Again." Repeat again.

Mr. STORROW. 4.28 o'clock.

Prof. BARKER (at receiver). "S-t-e-a-k-b-o-n."

Mr. MARK, Jr. (at telltale). "S-t-e-a-k-b-o-n."

Prof. BARKER (at receiver). "S-t-a-e-k —"

Mr. MARX, Jr. (at telltale). "S-t-a-e-k —"

Prof. BARKER (at receiver). "O, not A."

Mr. MARX, Jr. (at telltale). "O, not A."

Prof. BARKER (at receiver). "Mr. Stockton and others, —"

Mr. MARX, Jr. (at telltale). "Mr. Stockton and others, —"

Mr. STORROW. 4.29 o'clock.

Prof. BARKER. Repeat.

Mr. MARX, Jr. (at telltale). "Repeat."

Prof. BARKER (at the receiver). "will tell Mr. Cleveland —"

Mr. MARX, Jr. (at telltale). "will tell Mr. Cleveland —"

Prof. BARKER (at receiver). "why they think — "

Mr. MARX, Jr. (at telltale). "why they think — "

Prof. BARKER (at receiver). "he should choose these gentlemen — "

Mr. MARX (at telltale). "he should choose these gentlemen — "

Prof. BARKER (at receiver). "for posts on the executive board."

Mr. STORROW. 4.30 o'clock.

Mr. MARX, Jr. (at telltale). "for posts on the executive board."

Prof. BARKER (at the receiver). "That is the end of the article, professor."

Mr. MARX, Jr. (at telltale). "That is the end of the article, professor."

Prof. BARKER (at receiver). "How is the adjustment now?" Answer, very good.

Mr. MARX, Jr. (at telltale). "How is the adjustment now?" "Answer, very good."

Prof. BARKER (at receiver). "I have not adjusted it since I commenced to read the article — "

Mr. MARX, Jr. (at receiver). "I have not adjusted it since I commenced to read the article — "

Prof. BARKER (at receiver). "the second time."

Mr. MARX (at telltale). "the second time."

Prof. BARKER (at receiver). "I have held it in my hand all the time."

Mr. MARX, Jr. (at telltale). "I have held it in my hand all the time."

Mr. STORROW. 4.31 o'clock.

Prof. BARKER (at receiver). "What receiver have you now on your end of the line?"

Mr. MARX, Jr. (at telltale). "What receiver have you now on your end of the line?"

Prof. BARKER. Answer, I_1.

Mr. MARX. Jr. (at telltale). "Answer, I_1."

Prof. BARKER (at receiver). "Now will you remove I_1, and substitute an instrument of the B form?" Answer, I will.

Mr. MARX, Jr. (at telltale). "Now will you remove I_1, and sub-

stitute an instrument of the B form?" "Yes." You asked, how did that commence? (*To Prof. Barker.*)

Prof. BARKER (at receiver). "Now will you remove the instrument I, and substitute an instrument of the B form?"

Mr. MARX Jr. (at telltale). "Now will you remove the instrument I, and substitute one of the B form?" "Answer, yes."

Mr. STORROW. 4.32 o'clock.

[*Mr. Marx, Sen., at this point took the position at the telltale instrument.*]

Mr. MARX, Sen. (at telltale). We are ready here. Ready.

Mr. STORROW. 4 33 o'clock.

Prof. BARKER (at receiver). "What receiver have you now on?"

Mr. MARX, Sen. (at the telltale). "What receiver have you now on?"

Prof. BARKER. Answer.

Mr. MARX, Sen. (at the telltale). "Answer."

Prof. BARKER. — B_2.

Mr. MARX, Sen. (at telltale). "B_2."

Prof. BARKER (at receiver). "How is the articulation with this instrument?"

Mr. MARX, Sen. (at telltale). "How is the articulation with this instrument?"

Prof. BARKER. Answer, the articulation is good.

Mr. MARX, Sen. (at telltale). "Answer, the articulation is good."

Prof. BARKER. But it is weak.

Mr. MARK, Sen. (at telltale). "But it is weak."

Mr. STORROW. 4.34 o'clock.

Prof. BARKER (at receiver). "We will have it adjusted a little, then."

Mr. MARX, Sen. (at telltale). "We will have it adjusted a little, then."

Prof. Barker. Answer, yes, if you please.

Mr. MARX, Sen. (at telltale). "Answer, yes, if you please."

Prof. BARKER (at receiver). "How is it now?" Answer, it is much better.

Mr. MARX, Sen. (at telltale). "How is it now?" "Answer, it is much better."

Prof. BARKER (at receiver). "Is it well enough adjusted now?"

Mr. MARX, Sen. (at telltale). "Is it well enough adjusted now?"

Mr. STORROW. 4.35 o'clock.

Prof. BARKER (at receiver). "Please answer back."

Mr. MARX, Sen. (at telltale). "Please answer back."

Prof. BARKER. Answer, it is in fair adjustment now.

Mr. MARX, Sen. (at telltale). "It is in fair adjustment now." "Answer, it is in fair adjustment now."

Prof. BARKER. Repeat, please.

Mr. MARX, Sen. (at telltale). "Repeat, please." The answer was that the instrument is in fair adjustment now.

Prof. BARKER (at receiver). "What time do you generally go to dinner?"

Mr. MARX, Sen. (at telltale). "What time do you generally go to dinner?"

Prof. BARKER (at receiver). "It is now twenty-five minutes past five."

Mr. MARX, Sen. (at telltale). "It is now twenty-five minutes —"

Prof. BARKER (at receiver). "of five, I suppose."

Mr. MARX, Sen. (at telltale). "It is now twenty-five minutes of five."

Mr. STORROW. 4.37 o'clock.

Prof. BARKER (at receiver). "I will talk to you a little upon the B receiver, —"

Mr. MARX, Sen. (at telltale). "I will talk to you a little upon the B receiver, —"

Prof. BARKER. Repeat, please.

Mr. MARX, Sen. (at telltale). "Repeat, please."

Prof. BARKER (at receiver). "in order to test that instrument."

Mr. MARX, Sen. (at telltale). "in order to test that instrument."

Prof. BARKER (at receiver). "How do you get the tones now?"

Mr. MARX, Sen. (at telltale). "How do you get the tones now?"

Prof. BARKER. Answer, pretty well.

Mr. MARX, Sen. (at telltale). "Answer, pretty well."

Prof. BARKER (at receiver). "This is a very pleasant day."

Mr. MARX, Sen. (at telltale). "This is a very pleasant day."

Prof. BARKER (at receiver). "Washington is one hundred and twenty miles from Harrisburg."

Mr. MARX, Sen. (at telltale). "Washington is one hundred and twenty miles from Harrisburg."

Mr. STORROW. 4.38 o'clock.

Prof. BARKER (at receiver). "I will count regularly a series of numbers."

Mr. MARX, Sen. (at telltale). "I will count regularly a series of numbers."

Prof. BARKER (at receiver). "1, 5, 10, 24."

Mr. MARX, Sen. (at telltale). "1, 5, 10, 24."

Prof. BARKER (at receiver). "39, 33, 37, 40."

Mr. MARX, Sen. (at telltale). "39, 33, 37, 40."

Mr. STORROW. 4.39 o'clock.

Prof. BARKER (at receiver). "45, 57, 68."

Mr. MARX, Sen. (at telltale). "45, 57, 68."

Prof. BARKER (at receiver). "74, 81, 93."

Mr. MARX (at telltale). "74, 81, 93."

Prof. BARKER (at receiver). "113, 125, 150."

Mr. MARX, Sen. (at telltale). "113, 125, 150."

Mr. STORROW. 4.40 o'clock.

Prof. BARKER (at receiver). "113, 125, 150."

Mr. MARX, Sen. (at telltale). "113, 125, 150."

Prof. BARKER (at receiver). "135."

Mr. MARX, Sen. (at telltale). "135."

Prof. BARKER (at receiver). "150."

Mr. MARX, Sen. (at telltale). "150."

Prof. BARKER (at receiver). "60."

Mr. MARX (at telltale). "60."

Prof. BARKER (at receiver). "210."

Mr. MARX, Sen. (at receiver). "210."

Prof. BARKER (at receiver). "330."

Mr. MARX, Sen. (at telltale). "330."

Mr. STORROW. 4.41 o'clock.

Prof. BARKER (at receiver). "20."

Mr. MARX, Sen. (at telltale). "20."

Prof. BARKER (at receiver). "401."

Mr. MARX, Sen. (at telltale). "401."

Prof. BARKER (at receiver). "901."

Mr. MARX, Sen. (at telltale). "901."

Prof. BARKER (at receiver). 1876.

Mr. MARX, Sen. (at telltale). "1876."

Prof. BARKER (at receiver). 1885.

Mr. MARX, Sen. (at telltale). "1885."

Prof. BARKER (at receiver). "How does the adjustment of this instrument hold out?" Answer, very good.

Mr. MARX, Sen. (at telltale). "How does the adjustment of this instrument hold out?" "Answer, very good."

Mr. STORROW. 4.42 o'clock.

Prof. BARKER (at receiver). "I have not adjusted it since I begun to read the newspaper article a second time."

Mr. MARX, Sen. (at telltale). "I have not adjusted it since I begun to read the newspaper article a second time."

Prof. BARKER (at receiver). "I will now remove this instrument and put on an instrument of the C form."

Mr. MARX, Sen. (at telltale). "I will now remove this instrument and put on an instrument of the C form."

Mr. STORROW. 4.43 o'clock.

Prof. BARKER (at receiver). "Are you ready?"

Mr. MARX, Sen. (at telltale). "Are you ready?" Yes. (*To Prof. Barker.*) I take the liberty to answer. Hold on a minute, Mr. Heiges.

Mr. STORROW. 4.44 o'clock.

Prof. BARKER (*speaking of the tin-cup instrument at his ear*). That tin is sharp.

Mr. MARX, Sen. (at telltale). Hello, Mr. Heiges! Does the judge wish the professor to put the instrument I on this line,— on this end? All right. Put on instrument "I,"— yes. This is hard work on this end, Judge. The professor is getting tired. We are ready now. All right; he will be ready in a minute. All right,— ready.

Prof. BARKER (at the receiver). "Hello! do you hear me now?"

Mr. MARX, Sen. (at telltale). "Hello! do you hear me now?"

Prof. BARKER. Answer, yes.

Mr. STORROW. 4.46 o'clock.

Prof. BARKER (at receiver). "Well, how plainly do you hear me?"

Mr. MARX, Sen. (at telltale). "Well, how plainly do you hear me?"

Prof. BARKER. Answer, distinctly, but not very loud.

Mr. MARKS, Sen. (at telltale). "Answer, distinctly, but not very loud."

Prof. BARKER (at receiver). "Are you getting tired of listening, Professor Barker?"

Mr. MARX, Sen. (at telltale). "Are you getting tired of listening, Professor Barker?" Answer, yes, from my side.

Prof. BARKER (at receiver). Not of listening, now that I have a receiver with a smoother edge.

Mr. MARX, Sen. (at telltale). Hello! "Answer, not of listening now, since I have a receiver with smoother edge." The professor says he is not tired of listening now, since he has a receiver of smoother edge.

Mr. STORROW. 4.47 o'clock.

Mr. MARX, Sen. (at telltale). Well, you may pass it; it is all right. Go ahead.

Prof. BARKER (at receiver). "Now are you all ready again?"

Mr. MARX, Sen. (at telltale). "Now are you all ready again?"

Prof. BARKER. Answer, yes.

Mr. MARX, Sen. (at telltale). "Answer, yes."

Prof. BARKER (at receiver). "Mr. Drawbaugh and a Mr. Jacobs are both standing up."

MR. MARX, Sen. (at telltale). "Mr. Drawbaugh and a Mr. Jacobs are both standing up."

Mr. STORROW. 4.48 o'clock.

Prof. BARKER (at receiver). "Mr. Dickerson is examining the instrument F, —"

Mr. MARX, Sen. (at telltale). "Mr. Dickerson is examining the instrument F, —"

Prof. BARKER (at receiver). "and has already taken it apart."

Mr. MARX, Sen. (at telltale). "and has already taken it apart."

Prof. BARKER (at receiver). "Mr. Pope and another gentleman are examining it with him."

Mr. MARX, Sen. (at telltale). "Mr. Pope and another gentleman are examining it with him."

Prof. BARKER (at receiver). "It is now ten minutes of five, —"

Mr. MARX, Sen. (at telltale). "It is now ten minutes of five, —"

Mr. STORROW. 4.49 o'clock.

Prof. BARKER (at receiver). "and I will put this test through as rapidly as possible."

Mr. MARX, Sen. (at telltale). "and I will put this test through as rapidly as possible."

Prof. BARKER (at receiver). "General Grant is said to be quite ill."

Mr. MARX, Sen. (at telltale). "General Grant is said to be quite ill."

Prof. BARKER (at receiver). "He is afflicted with a trouble of the throat, —"

Mr. MARX, Sen. (at telltale). "He is afflicted with a trouble of the throat, —"

Prof. BARKER (at receiver). "caused by an excessive use of tobacco, —"

Mr. STORROW. 4.50 o'clock.

Mr. MARX, Sen. (at telltale). "caused by an excessive use of tobacco, —"

Prof. BARKER (at receiver). "and Mr. Drawbaugh —"

Mr. MARX, Sen. (at telltale). "Tell Mr. Drawbaugh —"

Prof. BARKER (*correcting*). "and Mr. Drawbaugh —"

Mr. MARX, Sen. (at telltale). "and Mr. Drawbaugh —"

Prof. BARKER. (at telltale). He mixed up with your talk.

Mr. MARX, Sen. (at telltale). "and Mr. Drawbaugh —"

Prof. BARKER (at receiver). "when he had just heard me say this —"

Mr. MARX, Sen. (at telltale). "when he had just heard me say this —"

Prof. BARKER (at receiver). "threw his tobacco away."

Mr. MARX, Sen. (at telltale). "threw his tobacco away."

Prof. BARKER (at receiver). "Mr. Ott, the examiner, —"

Mr. MARX, Sen. (at telltale). "Mr. Ott, the examiner, — "

Mr. STORROW. 4.51 o'clock.

Prof. BARKER (at receiver). "is looking — "

Mr. MARX, Sen. (at telltale). "is looking — "

Prof. BARKER (at receiver). "quite impatient, — "

Mr. MARX, Sen. (at telltale). "quite impatient, — "

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Quite impatient." That was the word; you wished them to —

Prof. BARKER (*To Mr. Marx, Sen.*) Hush! I can't get it.

Mr. MARX, Sen. (at telltale). The professor wishes you to repeat.

Prof. BARKER (at receiver). "and says that the reason of it is — "

Mr. MARX, Sen. (at telltale). "and says that the reason of it is — "

Mr. STORROW. 4.52 o'clock.

Prof. BARKER (at receiver). "that he had the toothache."

Mr. MARX, Sen. (at telltale). "that he had the toothache."

Prof. BARKER (at receiver). "I don't wonder at his expression, if such is the case."

Mr. MARX, Sen. (at telltale). "I don't wonder at his expression, if such is the case."

Prof. BARKER (at receiver). "I have been talking through the C instrument — "

Mr. MARX, Sen. (at telltale). "I have been talking through the C instrument — "

Prof. BARKER (at receiver). "with a battery on the line."

Mr. MARX, Sen. (at telltale). "with a battery on the line."

Prof. BARKER (at receiver). "I will now have Mr. Heiges remove the battery."

Mr. STORROW. 4.53 o'clock.

Mr. MARX, Sen. (at telltale). "I will now have Mr. Heiges remove the battery."

Prof. BARKER (at receiver). "Hello, professor!"

Mr. MARX, Sen. (at telltale). "Hello, professor!"

Mr. STORROW. 4.54 o'clock.

Prof. BARKER (at receiver). "Do you hear me now?"

Mr. MARX, Sen. (at telltale). "Do you hear me now?"

Prof. BARKER (at receiver). "Can you hear as plainly as you did with the battery on?"

Mr. MARX, Sen. (at telltale). "Can you hear as plainly as you did with the battery on?"

Prof. BARKER. Answer, yes.

Mr. MARX, Sen. (at telltale). "Answer, yes." "Yes."

Prof. BARKER (at receiver). "I had Mr. Heiges remove the battery."

Mr. MARX, Sen. (at telltale). "I had Mr. Heiges remove the battery."

Prof. BARKER (at receiver). "I have got tired of talking, and will let Mr. Drawbaugh take my place awhile."

Mr. MARX, Sen. (at telltale). "I have got tired of talking, and will let Mr. Drawbaugh take my place awhile."

Mr. STORROW. 4.55 o'clock.

Prof. BARKER (at receiver). "Professor Barker, are you all ready?"

Mr. MARX, Sen. (at telltale). "Professor Barker, are you all ready?"

Prof. BARKER. Mr. Drawbaugh's voice.

Mr. MARX, Sen. (at telltale). "Mr. Drawbaugh's voice." The professor says it is in Mr. Drawbaugh's voice,—this question. The professor says that the question was asked in Mr. Drawbangh's voice.

Mr. STORROW. 4.56 o'clock.

Prof. BARKER. Repeat, please.

Mr. MARX, Sen. (at telltale). "Repeat, please."

Prof. BARKER (at receiver). "Judge Hill is now walking the floor."

Mr. MARX, Sen. (at telltale). "Judge Hill is now walking the floor."

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER (at receiver). "I suppose he is tired."

Mr. MARX, Sen. (at telltale). "I suppose he is tired."

Mr. STORROW. 4.57 o'clock.

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER (at receiver). "I will now give you a little —"

Mr. MARX, Sen. (at telltale). "I will now give you a little —"

Prof. BARKER. Repeat the rest.

Mr. MARX, Sen. (at telltale). "Repeat the rest."

Prof. BARKER. Repeat again.

Mr. STORROW. 4.58 o'clock.

Mr. MARX, Sen. (at telltale). "Repeat again." All right. Wait a moment; one moment.

Mr. STORROW. 4.59 o'clock.

Mr. MARX, Sen. (at telltale). We are ready now.

Mr. STORROW. 5 o'clock.

Prof. BARKER (at receiver). "I have changed the adjustment a little. Does it seem any better now?"

Mr. MARX, Sen. (at telltale). "I have changed the adjustment a little. Does it seem any better now?"

Prof. BARKER. Answer, yes, a trifle better.

Mr. MARX, Sen. (at telltale). Answer, "yes, a trifle better."

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Mr. STORROW. 5.1 o'clock.

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER. I do not understand.

Mr. MARX, Sen. (at telltale). "I do not understand."

Mr. STORROW. 5.02 o'clock.

Prof. BARKER. I cannot get it.

Mr. MARX, Sen. (at telltale). "I cannot get it."

[*At this point a man came into the room with some lamps, and made considerable noise in lighting them.*]

Mr. MARX, Sen. (at the telltale). Hold on a moment.

Mr. STORROW. 5.05 o'clock.

Mr. MARX, Sen. (at telltale). Are you ready? What say? All right! Go ahead.

Prof. BARKER (at receiver). "Professor, what receiver have you at the end of the line?"

Mr. MARX, Sen. (at telltale). "Professor, what receiver have you at the end of the line?"

Prof. BARKER. Answer, an "I" receiver.

Mr. MARX, Sen. (at telltale). Answer, an "I" receiver. Hold on a minute. We have had an explosion here! (*referring to the breaking of a lamp chimney.*)

Prof. BARKER (*to Judge Hill, who had just come into the room*). Have you somebody else you want to listen awhile?

Mr. HILL. I can't hear anything on the telephone. We will be through soon. I will make this test, and another test with another pair of instruments.

Prof. BARKER. I can't understand Mr. Drawbaugh when he talks to me straight, much less with a telephone. He varies his tone up and down a good deal.

Mr. HILL (at the telltale). "Is somebody at the telltale?"

Prof. BARKER (*to Mr. Hill*). If you don't hear well, you transmit well. There is no doubt about that.

Mr. HILL. I will talk through the telltale.

Prof. BARKER. That don't let it come in. It is like the polarization.

Mr. HILL. That seemed to stick you or Heiges. (At telltale.) "Hello, hello, Heiges." Are you all ready over there now? Boom along. The instrument "I" is on our end now as a receiver.

Mr. STORROW. 5.08 o'clock.

Prof. BARKER (at receiver). "Hello!"

Mr. HILL. (at telltale). "Hello!" All right. Go ahead.

Prof. BARKER (at receiver). "Professor, I will give you some numbers."

Mr. HILL (at telltale). "Professor, I will give you some numbers."

Prof. BARKER (at receiver). "1, 2, 4."

Mr HILL (at telltale), "1, 2, 4."

Prof. BARKER (at receiver). "8, 11, 9, 12."

Mr. HILL (at telltale). "8, 11, 9, 12."

Prof. BARKER (at receiver). "17."

Mr. HILL (at telltale). "17."

Mr. STORROW. 5.09 o'clock.

Prof. BARKER (at receiver). "18."

Mr. HILL (at telltale). "18."

Prof. BARKER (at receiver). "21."

Mr. HILL (at telltale), "21."

Prof. BARKER (at receiver). "11."

Mr. HILL (at telltale). "11."

Prof. BARKER (at receiver). "15."

Mr. HILL (at telltale). "15."

Prof. BARKER (at receiver). "11, 15, 31."

Mr. HILL (at telltale). "11, 15, 31."

Prof. BARKER (at receiver). "17, 23, 40."

Mr. HILL (at telltale). "17, 23, 40."

Mr. STORROW. 5.10 o'clock.

Prof. BARKER (at receiver). "I am now getting tired."

Mr. HILL (at telltale). "I am now getting tired."

Prof. BARKER (at receiver). "I will leave some one else to speak."

Mr. HILL (at telltale). "I will leave some one else to speak."

Prof. BARKER (at receiver). "Professor, will you ask Judge Hill if he hasn't — a — " Repeat the rest.

Mr. HILL (at telltale). "Professor, will you please ask Judge Hill if he hasn't — a — " "Please repeat the rest."

Mr. STORROW. 5.11 o'clock.

Prof. BARKER. Don't get it; away off.

Mr. HILL (at telltale). "Don't get it." Speak louder. Hello, Heiges! The lamp has just broken again. Wait a minute. Well, now are you ready; go on. Go ahead.

Mr. STORROW. 5.12 o'clock.

Prof. BARKER. Repeat.

Mr. HILL (at telltale). "Please repeat."

Prof. BARKER. I can't get it.

Mr. HILL (at telltale). "Can't get it; repeat."

Prof. BARKER. No.

Mr. HILL (at telltale). "No."

Mr. STORROW. 5.13 o'clock.

Mr. HILL (at telltale). Hold on a moment. I didn't get you all. Somebody came in at the moment. Please repeat.

Mr. STORROW. 5.14 o'clock.

Mr. HILL (at telltale). Well, tell him to ask the question again.

Prof. BARKER (at receiver). "Tell him to ask Judge Hill if he hasn't a new kind of talk."

Mr. STORROW. 5.15 o'clock.

Mr. HILL (at telltale). "Tell him to ask Judge Hill if he hasn't a new kind of talk."

Prof. BARKER. Do not get the last word.

Mr. HILL (at telltale). Professor Barker says he does not get the last word.

Prof. BARKER (at receiver). "If he has not had enough of this kind of talk?"

Mr. HILL (at telltale). "If he has not had enough of this kind of talk?"

Mr. STORROW. 5.16 o'clock.

Prof. BARKER. I wish he would ask me that question.

Mr. HILL. Hello, Heiges! Ask Dan how he is feeling.

Prof. BARKER (at receiver). "I am feeling pretty warm; and I think I'll have to go."

Mr. HILL (at telltale), "I am feeling pretty warm. I think I'll have to go." "I am feeling pretty warm. I think I'll have to go." (*Repeating.*)

Mr. STORROW. 5.17 o'clock.

Prof. BARKER (at receiver). "I have a cold."

Mr. HILL (at telltale). "I have a cold."

Prof. BARKER. Repeat.

Mr. HILL (at telltale). "Repeat."

Prof. BARKER. Again.

Mr. HILL (at telltale). "Repeat again."

Mr. STORROW. 5.18 o'clock.

Prof. BARKER. Don't get it.

Mr. HILL (at telltale). "Don't get it." Put on another instrument "C," Heiges.

Mr. STORROW. 5.21 o'clock.

[*At this point, Mr. Marx, Sen., took the position at the telltale instrument, and Mr. Hill left the room.*]

Mr. MARX, Sen. (at telltale). We are ready here, I believe. All right, now.

Prof. BARKER (at receiver). "Professor Barker, do you hear me now?"

Mr. MARX, Sen. (at telltale). "Professor Barker, do you hear me now?"

Prof. BARKER (at receiver). "We have changed the instrument and put on another 'C' instrument."

Mr. MARX, Sen. (at telltale). "We have changed the instrument for another 'C' instrument."

Prof. BARKER (*correcting*). "And put on another 'C' instrument."

Mr. MARX, Sen. (at telltale). "And put on another 'C' instrument."

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER (at receiver). "Judge Hill is now walking the floor of this room, —"

Mr. STORROW. 5.22 o'clock.

Mr. MARX, Sen. (at telltale). "Judge Hill is now walking the floor of this room, —"

Prof. BARKER (at receiver). "and Mr. Jacobs is sitting on the bed in this room."

Mr. MARX, Sen. (at telltale). "and Mr. Jacobs is sitting on the bed in this room."

Prof. BARKER (at receiver). "Harrisburg is the capital of Pennsylvania."

Mr. MARX, Sen. (at telltale). "Harrisburg is the capital of Pennsylvania."

Prof. BARKER (at receiver). "It is situated on the east bank of the Susquehanna River."

Mr. MARX, Sen. (at telltale). "It is situated on the east bank of the Susquehanna River."

Mr. STORROW. 5.24 o'clock.

Prof. BARKER (at receiver). "I see a number of overcoats lying on these beds."

Mr. MARX, Sen. (at telltale). "I see a number of overcoats lying on these beds."

Prof. BARKER (at receiver). "Also a number of hats."

Mr. MARX, Sen. (at telltale). "Also a number of hats."

Mr. STORROW. 5.23 o'clock.

Prof. BARKER (at receiver). "Now I will give this to Judge Hill, and let him speak in it."

Mr. MARX, Sen. (at telltale). "Now I will give this to Judge Hill, and let him speak in it."

Prof. BARKER (at receiver). "Hello, Professor Barker!"

Mr. MARX, Sen. (at telltale). "Hello, Professor Barker!"

Mr. STORROW. 5.24 o'clock.

Prof. BARKER (at receiver). "How plainly do you hear me?"

Mr. MARX, Sen. (at telltale). "How plainly do you hear me?"

Prof. BARKER. Answer, very well.

Mr. MARX, Sen. (at telltale). "Answer, very well."

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER (at receiver). "Are you getting tired and ready to quit that?"

Mr. MARX, Sen. (at telltale). "Are you getting tired and ready to quit that?"

Prof. BARKER (at receiver). "Quit there," instead of "that."

Mr. MARX, Sen. (at telltale). "Quit there, instead of that."

Prof. BARKER. Repeat. I wasn't listening.

Mr. MARX, Sen. (at telltale). "Repeat; I wasn't listening."

Mr. STORROW. 5.25 o'clock.

Prof. BARKER (at receiver). "How is that lamp in your room? Has there been another explosion?"

Mr. MARX, Sen. (at telltale). "How is that lamp in your room? Has there been another explosion?" Answer, we are expecting one. (*Repeating*). "Answer, we are expecting another explosion."

Prof. BARKER (at receiver). "That lamp is made of dynamite."

Mr. MARX, Sen. (at telltale). "That lamp is made of dynamite."

Mr. STORROW. 5.26 o'clock.

Prof. BARKER (at receiver). "I said it was worse than dynamite."

Mr. MARX, Sen. (at telltale). "I said it was worse than dynamite."

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER (at receiver). "The British Lion—" is all I got.

Mr. MARX, Sen. (at telltale). "The British Lion—" is all we got here.

Prof. BARKER (at receiver). "would turn tail and run away before that lamp."

Mr MARX, Sen. (at telltale). "would turn tail and run before that lamp."

Mr. STORROW. 5.27 o'clock.

Prof. BARKER (at receiver). "Do you know where Governor Cleveland is to-day?"

Mr. MARX, Sen. (at telltale). "Do you know where Governor Cleveland is to-day?"

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER. Again.

Mr. MARK, Sen. (at telltale). "Again."

Prof. BARKER (at receiver). "I said I would like to ask him to appoint me to an office, —"

Mr. MARX, Sen. (at telltale). "I said I would like to ask him to appoint me to an office, —"

Mr. STORROW. 5.28 o'clock.

Prof. BARKER (at receiver). "but I don't believe he would do it."

Mr. MARX, Sen. (at telltale). "but I don't believe he would do it."

Prof. BARKER (at receiver). "Have you any idea who his cabinet will be?"

Mr. MARX, Sen. (at telltale). "Have you any idea who his cabinet will be?"

Prof. BARKER (at receiver). "I don't expect a cabinet appointment myself, —"

Mr. MARX, Sen. (at telltale). "I don't expect a cabinet appoin ment myself, —"

Mr. STORROW. 5.29 o'clock.

Prof. BARKER (at receiver). "but I hope he will make some good ones when he makes them."

Mr. MARX, Sen. (at telltale) "but I hope he will make some good ones when he makes them."

Prof. BARKER (at receiver). "The Atlantic Ocean is three thousand miles wide."

Mr. MARX, Sen. (at telltale). "The Atlantic Ocean is three thousand miles wide."

Prof. BARKER (at receiver). "The sun is about ninety-four millions of miles from the earth."

Mr. MARX, Sen. (at telltale). "The sun is about ninety-four millions of miles from the earth."

Mr. STORROW. 5.30 o'clock.

Prof. BARKER (at receiver). "The moon is about 240,000 miles from the earth."

Mr. MARX, Sen. (at telltale). "The moon is about 240,000 miles from the earth."

Prof. BARKER (at receiver). "How many students in the law class were examined at the University the other day?"

Mr. MARX, Sen. (at the telltale). "How many students in the law class were examined at the University the other day?"

Mr. STORROW. 5.31 o'clock.

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat." Hold on a moment, there is so much noise here now. Now repeat.

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Repeat again."

Prof. BARKER (at receiver). "Professor Barker, will you remove the instrument 'I'?"

Mr. MARX, Sen. (at telltale). "Professer Barker, will you remove the instrument 'I'?"

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER (at receiver). "I said you need not remove it just yet."

Mr. MARX, Sen. (at telltale). "I said you need not remove it just yet."

Prof. BARKER (at receiver). "I want to talk a little more before you remove it."

Mr. MARX, Sen. (at telltale). "I want to talk a little more before you remove it."

Prof. BARKER (at receiver). "I think I was talking too loud into this transmitter."

Mr. MARX, Sen. (at telltale). "I think I was talking too loud into this transmitter."

Prof. BARKER (at receiver). "You seem to hear me more plainly now, do you not?"

Mr. MARX, Sen. (at telltale). "You seem to hear me more plainly now, do you not?"

Prof. BARKER. Answer, yes, I hear you very well.

Mr. MARX, Sen. (at telltale). "Yes, I hear you very well."

Prof. BARKER (at receiver). "It has been a pleasant day, and is a very pleasant evening."

Mr. MARX, Sen. (at telltale). "It has been a pleasant day, and is a pleasant evening."

Prof. BARKER (at receiver). "The sky seems to be entirely clear of clouds."

Mr. MARX, Sen. (at telltale). "The sky seems to be entirely clear of clouds."

Prof. BARKER (at receiver). Repeat.

Mr. MARX, Sen. (at telltale). "Repeat." "Repeat."

Prof. BARKER (at receiver). "The air is crisp and cold,—"

Mr. MARX, Sen. (at telltale). "The air is crisp and cold,—"

Prof. BARKER (at receiver). "and a great many pretty girls are on the street this afternoon,—"

Mr. MARX, Sen. (at telltale). "and a great many pretty girls are on the street this afternoon,—"

Prof. BARKER (at receiver). "but I have no time to stop and admire them."

Mr. MARX, Sen. (at telltale). "but I have no time to stop and admire them."

Prof. BARKER (at receiver). "Perhaps that might have had something to do with your being so late."

Mr. MARX, Sen. (at telltale). "Perhaps that might have had something to do with your being so late."

Prof. BARKER (at receiver). "I do not blame anybody for stopping to look along the street at pretty girls."

Mr. MARX, Sen. (at telltale). "I do not blame anybody for stopping along the street to look at pretty girls —" Well, what is it? Give the answer again? I have got to get it from the reporter here.

[*The stenographer then repeated the message again, of Prof. Barker.*]

Mr. MARX, Sen. (at telltale). "I do not blame anybody for stopping to look along the street at pretty girls —"

Prof BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER (at receiver). "on such a day."

Mr. MARX, Sen. (at telltale). "on such a day."

Prof. BARKER (at receiver). "Now I will speak considerably lower than I have been speaking."

Mr. MARX, Sen. (at telltale). "Now I will speak considerably lower than I have been speaking."

Prof. BARKER (at receiver). "How did you get that?"

Mr. MARX, Sen. (at telltale). "How did you get that?"

Prof, BARKER. Answer, very well.

Mr. MARX, Sen. (at telltale). "Answer, very well."

Prof. BARKER (at receiver). "Now I am speaking lower still. How do you get that?" Answer, better than before.

Mr. MARX, Sen. (at telltale). "Now I am speaking lower still. How do you get that?" "Answer, better than before."

Prof. BARKER (at receiver). "Then I have been speaking too loud in the early part of the experiments."

Mr. MARX, Sen. (at telltale). "Then I have been speaking too loud in the early part of the experiments."

Prof. BARKER (at receiver). "How is the articulation on this instrument?"

Mr. MARX, Sen. (at telltale). "How is the articulation on this instrument?"

Prof. BARKER (at receiver). "You get me all right now, don't you?"

Mr. MARX, Sen. (at telltale). "You get me all right now, don't you?"

Prof. BARKER. Answer, yes.

Mr. MARX, Sen. (at telltale). "Answer, yes."

Prof. BARKER (at receiver). "I can just see the top of Mr. Marx's head through the window."

Mr. MARX, Sen. (at telltale). "I can just see the top of Mr. Marx's head through the window." Answer, that is moonshine—moonshine—full moon. (*To stenographer.*) "You needn't take that down."

Prof. BARKER (at receiver). "I suppose Mr. Marx did that." Repeat the first part of the sentence.

Mr. MARX, Sen. (at telltale). "I suppose Mr. Marx did that." "Repeat the first part of the sentence."

Prof. BARKER (at receiver). "I said, I am not responsible for its looking like the full moon."

Mr. MARX, Sen. (at telltale). "I am not responsible for its looking like a full moon."

Mr. STORROW. 5.40 o'clock.

Prof. BARKER (at receiver). "When do you want to return to your house, Professor Barker?"

Mr. MARX, Sen. (at telltale). "When do you want to return to your house, Professor Barker?"

Prof. BARKER. Answer, I dine at 6.

Mr. MARX, Sen. (at telltale). "I return at 6."

Prof. BARKER (at receiver). "It is now quarter of 6,—"

Mr. MARX, Sen. (at telltale). "It is now quarter of 6,—"

Prof. BARKER (at receiver). "and I will ask you to take out that instrument 'I' —"

Mr. MARX, Sen. (at telltale). "and I will ask you to take out that instrument 'I' —"

Prof. BARKER (at receiver). "and put on an instrument—"

Mr. MARX, Sen. (at telltale). "and put on an instrument—"

Prof. BARKER (at receiver). "of the 'C' form,—"

Mr. MARX, Sen. (at telltale) "of the 'C' form,—"

Mr. STORROW. 5.41 o'clock.

Prof. BARKER (at receiver). "of the 'B' form—"

Mr. MARX, Sen. (at telltale). "of the 'B' form—"

Prof BARKER (at receiver). "and I will put on the battery here."

Mr. MARX, Sen. (at telltale). "and I will put on the battery here."

Prof. BARKER (at receiver). "Are you ready now to make the test?"

Mr. MARX, Sen. (at telltale). "Are you ready now to make the test?"

Prof. BARKER. Answer, yes.

Mr. MARX, Sen. (at telltale). "Answer, yes."

Prof. BARKER. Go ahead.

Mr. MARX, Sen. (at telltale). "Go ahead."

Mr. STORROW. 5.42 o'clock.

Prof. BARKER. All right, tell him.

Mr. MARX, Sen. (at telltale). "All right." (*To Prof. Barker.*) They are not ready. (At telltale). You tell him when you have it on. Hello! we are ready; yes. One moment. Ready now.

Mr. STORROW. 5.43 o'clock.

Mr. MARX, Sen. (at telltale). What say? We don't get anything here. Hold on a minute; now go on. All right. (*To Prof. Barker.*) Hold on a minute, he says.

Prof. BARKER (at receiver). "There is no battery on this line at all."

Mr. MARX, Sen. (at telltale). "There is no battery on this line at all." One moment. Yes, very soon. Ready. In a minute. We are ready. Go on.

Mr. STORROW. 5.45 o'clock.

Mr. MARX, Sen. (*To Prof. Barker.*) Did you get anything?

Prof. BARKER. Nothing.

Mr. MARX, Sen. (at telltale). No. There seems to be a fault here.

Prof. Barker. Ask him what line he has got his instrument on.

Mr. MARX, Sen. (at telltale). What line have you your instrument on? (*After a pause.*) So we have here. Hold on one minute.

Mr. DRAWBAUGH (*who had just come into the room*). Perhaps you have jammed your poles. It is a little close. (*After adjusting.*) Now try it.

Mr. MARX, Sen. (at telltale). "Now go on."

Mr. STORROW. 5.47 o'clock.

Prof. BARKER (at receiver). "Hello!"

Mr. MARX, Sen. (at telltale). We are ready here. Go on.

Prof. BARKER (at receiver). "Hello!"

Mr. MARX, Sen. (at telltale). "Hello!"

Prof. BARKER (at receiver). "Do you hear me now?"

Mr. MARX, Sen. (at telltale). "Do you hear me now?"

Prof. BARKER (at receiver). "What was the matter with the line?"

Mr. MARX, Sen. (at telltale). "What was the matter with the line?"

Mr. STORROW. 5.48 o'clock.

Prof. BARKER. Repeat. It is very faint.

Mr. MARX, Sen. (at telltale). "Repeat. Very faint."

Prof. BARKER (at receiver). "Was your instrument out of adjustment?"

Mr. MARX, Sen. (at telltale). "Was your instrument out of adjustment?"

Prof. BARKER (at receiver). "Mr. Drawbaugh has just returned into this room?"

Mr. MARX, Sen. (at telltale). "Mr. Drawbaugh has just returned into this room."

Prof. BARKER (at receiver). "No, I was mistaken. It was not Dan Drawbaugh; it was another gentleman."

Mr. MARX, Sen. (at telltale). "No, I was mistaken. It was not Dan Drawbaugh; it is another gentleman."

Mr. STORROW. 5.49 o'clock.

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER (at receiver). "Now Dan is coming."

Mr. MARX, Sen. (at telltale). "Now Dan is coming."

Prof. BARKER (at receiver). "He has just come in the door."

Mr. MARX, Sen. (at telltale). "He has just come in the door."

Prof. BARKER (at receiver). "The instruments that are now on the line — "

Mr. MARX, Sen. (at telltale). "The instruments that are now on the line — "

Prof. BARKER (at receiver). "are instruments of the form of 'C' at this end, — "

Mr. MARX, Sen. (at telltale). "are instruments of the form of 'C' on this end, — "

Prof. BARKER (at receiver). "and the instrument of the form of 'B' on your end, — "

Mr. MARX, Sen. (at telltale). "and the instrument of the form of 'B' on your end, — "

Prof. BARKER (at receiver). "with a battery and line."

Mr. MARX, Sen. (at telltale). "with a battery and line."

Prof. BARKER (at receiver). "You hear perfectly well what I say, do you not?"

Mr. MARX, Sen. (at telltale). "You hear perfectly well what I say, do you not?"

Prof. BARKER. Answer, yes; it is weak, but it is distinct.

Mr. STORROW. 5.50 o'clock.

Mr. MARX, Sen. (at telltale). "Answer, yes; it is weak, but it is distinct." "It is weak, but it is distinct." Do you want the answer? "It is weak, but it is distinct."

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Mr. STORROW. 5.51 o'clock.

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER (at receiver). "Perhaps I am speaking too loud. How is this?"

Mr. MARX, Sen. (at telltale). "Perhaps I am speaking too loud. How is this?"

Prof. BARKER. Better.

Mr. MARX, Sen. (at telltale). "Better."

Prof. BARKER (at receiver). "Well, how is it now?"

Mr. MARX, Sen. (at telltale). "Hello! how is it now?"

Prof. BARKER (*correcting*). "Well."

Mr. MARX, Sen. (at telltale). "Well."

Prof. BARKER (at receiver). "Do you get me any better now?"

Mr. MARX, Sen. (at telltale). "Do you get me any better now?"

Mr. STORROW. 5.52 o'clock.

Prof. BARKER (at receiver). "Do you get me any better now than when I spoke loud?"

Mr. MARX, Sen. (at telltale). "Do you get me any better now than when I spoke loud?"

Prof. BARKER (at receiver). "What do you think about it?"

Mr. MARX, Sen. (at telltale). "What do you think about it?"

Prof. BARKER. Answer, yes, I think I do.

Mr. MARX, Sen. (at telltale). "Yes, I do." Answer.

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat." Hold on a minute.

Mr. STORROW. 5.53 o'clock.

Mr. MARX, Sen. (at telltale). Go on now. Repeat.

Prof. BARKER. There was noise in the next room.

Mr. MARX, Sen. (at telltale). "There was noise in the next room.'

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER (at receiver). "Hello! hello!"

Mr. MARX, Sen. (at telltale). "Hello! hello!"

Prof. BARKER (at receiver). "Do you hear me now?" Very low.

Mr. MARX, Sen. (at telltale). "Do you hear me now?" "Very low."

Mr. STORROW. 5.54 o'clock.

Prof. BARKER (at receiver). "Well, I will speak lower still. Do you hear me now?" Answer, yes.

Mr. MARX, Sen. (at telltale). "Well, I speak lower still. Do you hear me now?" "Answer, yes."

Prof. BARKER (at receiver). "Is that any better now?"

Mr. MARX, Sen. (at telltale). "Is that any better now?"

Prof. BARKER (at receiver). "How does that instrument compare with instrument 'I'?"

Mr. MARX, Sen. (at telltale). "How does that instrument compare with instrument 'I'?"

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER (at receiver). "It is now six o'clock. Are you about ready to stop?" Answer, yes.

Mr. MARX, Sen. (at telltale). "It is now six o'clock. Are you ready to stop?" "Answer, yes."

Mr. STORROW. 5.55 o'clock.

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER (at receiver). "I said, are you ready or not to stop?" I am ready.

Mr. MARX, Sen. (at telltale). "I said, are you ready or not to stop?" "Answer, I am ready."

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER (at receiver). "All right. We will do"—something—"once more, and then stop."

Mr. MARX, Sen. (at telltale). "All right." "We will"—"once more do something and then stop."

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat, if you please."

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER (at receiver). "We will say a few words more and then stop."

Mr. MARX, Sen. (at telltale). "We will say a few more words and then stop."

[illegible]ROW. 5.57 o'clock.

[illegible]RKER. Cannot hear. It is too faint.

[illegible]RX, Sen. (at telltale). "I cannot hear; it is too faint."

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). "Repeat."

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again." Repeat again, if you please.

Prof. BARKER. Can't hear at all.

Mr. MARX, Sen. (at telltale). "I cannot hear you at all." (*To Prof. Barker.*) Won't you see whether that pole hasn't again come together? (At telltale.) Hold on a moment. (*To Prof. Barker.*) Mr. Drawbaugh merely shoved it back, you know.

Prof. BARKER. No; the magnet is a little loose.

Mr. MARX, Sen. (at telltale). All right; the magnet here is a little loose. Go on. Now try again. Yes. Hold on a minute, he says.

Prof. BARKER (at receiver). "Hello!"

Mr. MARX, Sen. (at telltale). "Hello!"

Prof. BARKER (at receiver). "Do you hear me now more plainly?"

Mr. STORROW. 5.59 o'clock.

Mr. MARX, Sen. (at telltale). "Do you hear me now more plainly?"

Prof. BARKER. Repeat.

Mr. MARX, Sen. (at telltale). Again.

Prof. BARKER. Again.

Mr. MARX, Sen. (at telltale). "Again."

Prof. BARKER (at receiver). "The pole of this instrument has struck against the armature."

Mr. MARX, Sen. (at telltale). "The pole of this instrument has stuck against the armature."

Mr. STORROW. 6 o'clock.

Prof. BARKER (at receiver). "Well, Professor, is it time to go to supper now?"

Mr. MARX, Sen. (at telltale). "Professor, is it time to go to supper now?"

Prof. BARKER. Yes; I think it is.

Mr. MARX, Sen. (at telltale). "Yes; I think it is."

Prof. BARKER (at receiver). "What do you think about it?"

Mr. MARX, Sen. (at telltale). "What do you think about it?"

Prof. BARKER (at receiver). "Good by!"

Mr. MARX, Sen. (at telltale). "Good by!"

PHILADELPHIA, PA., Feb. 6, 1885.

Tests conducted at the Washington Hotel, in Philadelphia.

REPORT IN TRANSMITTING ROOM.

Mr. STORROW. Complainants' counsel requests the defendants' counsel to open the instrument of the "F" form, which he says he expects to try here; and also the instrument of the "C" form, which he says he expects to try here.

Mr. HILL. Respondents' counsel replies that he shall not allow any of the instruments to be taken apart nor tampered with in any way, until after the tests have been made with them; after which, all the instruments tested will be placed in the hands of the examiner, and can be inspected and examined by complainants' counsel at their own will, in the presence of the examiner.

Mr. DICKERSON. Complainants' counsel says that he has not asked that he be allowed to take them apart, and has not suggested that they be tampered with. His request is, that the defendants' counsel or his expert take them apart, in the presence of the complainants' counsel, that they may see their construction.

Mr. HILL. Respondents' counsel says that it is now almost three o'clock; a delay having occurred from half past twelve until the present time, by reason of the accidental detention of Prof. Barker at the University of Pennsylvania; and respondents' counsel has been informed by complainants' counsel, that complainants' experts are obliged to leave by the half past six train. There is,

therefore, no time to unnecessarily spend at this stage, and the respondents are ready now to proceed with the tests. After the tests have been made, the instruments will be taken charge of here by the examiner; and if the purpose of complainants' counsel is merely to know all about the construction of the instruments, that purpose can be served just as well by an examination of them after the tests as before; and it is not reasonable to ask us to delay the tests any further. We are now ready to proceed, and we ask complainants' counsel and the experts to take their stations in the transmitting and receiving rooms, as they may think best, and to proceed immediately with the tests.

Mr. DICKERSON. Complainants' counsel repeat the request that they have made, with thanks for the care which the defendants' counsel seem to take in the accommodation of the complainants' witnesses.

Mr. HILL. Respondents' counsel do not propose to waste any more time in this manner, and are now ready to go on with the tests. He asks the complainants' counsel whether they propose to go on, or not.

Mr. DICKERSON. Complainants' counsel are here under your notice, and ready to witness anything that takes place.

Mr. HILL. Well, we are ready to proceed with the tests. Mr. Marx, will you step to the telltale on that line, and tell Prof. Barker we are ready? Mr. Drawbaugh, will you just attach those?

[*Mr. Drawbaugh adjusts the wires.*]

Mr. HILL. Mr. Hill states that the first test will be made with an instrument of the "F" form, having the carbon box supported by a single stem, or rod, as the transmitter on the test line, which instrument is marked "F_2". The line is a metallic circuit, extending from room 29 to room 28 in the Washington Hotel, Philadelphia; the arrangement of the line being the same as described by Prof. Barker in his deposition. There is a battery in the line, consisting of two Le Clanche cells. The receiving instrument in room 28 is of the form known as "B." Besides this test line, there is a metallic circuit which will be used as a telltale line, it being equipped with two Tisdel magneto instruments, one at each end of the line.

Mr. DICKERSON. Counsel for the complainants object to the use

of a telltale line in aid of the experiments, it not being probable that Drawbaugh had a Tisdel telltale telephone line when he performed the experiments he testified to, unless it is proved that he had.

Mr. HILL. Respondents' counsel replies that the telltale line is used merely for convenience and to save time, and is substantially the same arrangement as was used in New York at the test there, about the 1st of April, 1882.

Mr. STORROW. Complainants' counsel observes that the arrangement and situation of the room appears, as testified to Prof. Barker, such that the operator at the transmitter and the operator at the receiver are in sight of each other; and he therefore requests that the window shades of one or both windows be drawn down.

Mr. HILL. Respondents' counsel replies that if the window shades can have the slightest effect upon the tests, in any conceivable way, they shall be drawn down as requested; and he directs Mr. Heiges to shut the window and draw down the shades.

[*The window of room 29 is now closed, and the shade in room 28 is drawn down.*]

Mr. HILL. Mr. Heiges, take a chair. Take the telltale.

[*Mr. Heiges takes a seat at the telltale.*]

Mr. HILL. Ask Prof. Barker to step over here and look at the transmitter which is on the line, and see which one it is.

[*Prof. Barker shortly enters room 29.*]

Prof. BARKER. That is "F_2."

Mr. HILL. Make a note of it, in your memorandum.

Mr. DICKERSON. When you begin to talk, I would like to have that telltale line detached.

Mr. HILL. You don't pretend that Mr. Barker can hear from the telltale instrument, which is in the hands of another man?

Mr. DICKERSON. I don't pretend at all.

Mr. HILL. Mr. Drawbaugh, take the seat.

[*Mr. Drawbaugh takes a seat in front of the instrument to be tested.*]

Mr. DRAWBAUGH. I will have to adjust it, you know.

Mr. HEIGES (at telltale). All right, now?

Mr. DRAWBAUGH (at transmitter). Now, Professor, I am speaking

into the tumbler instrument. I wish to adjust it. Is it right, the quality right now?

Mr. HEIGES (at telltale). "All right."

Mr. DRAWBAUGH (at transmitter). I am now speaking into the single stem instrument — tumbler instrument — instrument "F." Is the adjustment right?

Mr. HEIGES (at telltale). Do you hear anything? (*Listening.*) "No."

Mr. DICKERSON. Counsel for complainants now objects, after it appears that nothing can be heard through the "F_2," to having the telltale used as a means for setting up an adjustment that could not otherwise be done; it not being probable that in the trials at Eberly's Mills there was a talking telephone alongside of Fig. "F," by means of which an adjustment that could talk could be procured.

Mr. HILL. Respondents' counsel objects to the interruptions and delays interposed by complainants' counsel.

Mr. HEIGES (*to Mr. Drawbaugh*). Now, go on. Get the instrument adjusted. (At telltale.) Mr. Marx, are you ready over there, to listen? Listen now, and there will be some talking done.

Mr. HILL. Fix your attention, Mr. Drawbaugh, until you get it adjusted. Ask them about the adjustment.

Mr. HEIGES (*to Mr. Drawbaugh*). Speak in, and ask them if they hear you.

Mr. DRAWBAUGH (at transmitter). Do you hear me now? Do you hear me now? One, two, three, four.

[*Mr. Drawbaugh here removes the instrument from his mouth, and says:*] "I can't see where it is; Idon't know where the adjustment is."

Mr. DRAWBAUGH (at transmitter). One, two, three, four.

Mr. HILL. Just ask him, "Do you hear me now?"

Mr. DICKERSON (*to the stenographers*). It is sixteen minutes and a half. Write that in your notes.

Mr. DRAWBAUGH (at transmitter). Professor, do you hear me now? (*Listening.*) Can you hear anything now? (*Listening.*) Do you hear me now?

Mr. HEIGES (at telltale). "Who is there? What instrument have you?"

Mr. DRAWBAUGH (at transmitter). The "F" instrument; but I ought to have it adjusted. (*To Mr. Heiges.*) I want to know when they are ready. I can't tell.

Mr. HEIGES. He will be ready in a minute. I will tell you. Go on and adjust.

Mr. HILL. Ask him if Professor Barker is at the instrument?

Mr. HEIGES (at telltale). Is Professor Barker at the instrument now? (*Listening.*) Are you ready now? (*Listening.*) They are ready now. Go ahead.

Mr. DRAWBAUGH (at transmitter). Professor, do you hear me now? Is the adjustment right?

Mr. HEIGES (at telltale). "Professor, do you hear me now? Is the adjustment right?"

Mr. DRAWBAUGH (at transmitter). Now, I will count for you.

Mr. HEIGES (at telltale). Do you want it changed? Isn't it loud, distinct? How do you want it? (*Listening.*) "It is loose; it is not loud."

Mr. DICKERSON. Nineteen minutes.

Mr. DRAWBAUGH (at transmitter). How is it now?

Mr. HEIGES (at telltale). Can you tell any change; do you hear anything?

Mr. DRAWBAUGH (at transmitter). Now, I am speaking again. Is the instrument right?

Mr. HEIGES (at telltale). "It is not as good as before."

Mr. DRAWBAUGH (at transmitter). Now I will change the adjustment a little. How is it now?

Mr. HEIGES (at telltale). He says it is a little better.

Mr. DRAWBAUGH (at transmitter). Now, Professor, I will count for you.

Mr. HEIGES. He says it is getting better. He says you shall talk now.

Mr. DRAWBAUGH (at transmitter). Well, I will count. One, two, three, four, five, six.

Mr. HEIGES (at telltale). "One, two, three, four, five, six."

Mr. DRAWBAUGH (at transmitter). We are in room 29, Washington Hotel.

Mr. HEIGES. He says it is too loose, again.

Mr. DICKERSON (repeating). "He says it is too loose again."

Mr. HEIGES. No, I did not say that. He said it was too loose. He did not say "too loose again."

Mr. DICKERSON. Speak loud enough, so I shall not have to repeat it.

Mr. DRAWBAUGH (at transmitter). I have changed the adjustment. How is it now, Professor?

Mr. HEIGES (at telltale). "It is better. A little more."

Mr. DRAWBAUGH (at transmitter). Now, I will still change it again. How is it now?

Mr. HEIGES (at telltale). "Becoming better all the time."

Mr. DRAWBAUGH (at transmitter). Now I have changed it again. Is it better now?

Mr. HEIGES (at telltale). "Now I have changed it again. Is it better now?" "It is very good now."

Mr. DRAWBAUGH (at transmitter). We are now in room 29, in the Washington Hotel."

Mr. HEIGES (at telltale). "We are now in room 29, Washington Hotel."

Mr. DRAWBAUGH (at transmitter). I think now I will let Judge Hill take the instrument. (*To Judge Hill.*) Judge, you take it.

Mr. HILL. You hold on. I will tell you what to say.

Mr. DRAWBAUGH. I get bothered with them talking.

Mr. HEIGES (at telltale). Please repeat.

Mr. HILL. The telltale operator at room 29 requests the telltale operator at room 28 to repeat through the telltale line.

Mr. DICKERSON. No such matter. He didn't say anything through the telltale line.

Mr. HILL. That is what you said. You asked them to repeat.

Mr. DICKERSON. He didn't say it.

Mr. DRAWBAUGH. Are you ready?

Mr. HILL (*to Mr. Heiges*). Ask him that.

Mr. HEIGES (at telltale). Are you ready? (*Listening.*) "Yes."

Mr. DRAWBAUGH (at transmitter). Well, I hardly know what to say.

Mr. HILL (*to Mr. Marx*). Step over there and ask him to repeat through the telltale line, everything.

Mr. HEIGES (at telltale). "I hardly know what to say."

Mr. DRAWBAUGH (at transmitter). Shall I count again?

Mr. HILL. Wait.

Mr. DICKERSON (*to the stenographers*). Say twenty-five minutes there.

Mr. HEIGES. Now, go ahead.

Mr. HILL. Ask them if they are ready.

Mr. HEIGES (at telltale). Are you ready? (*Listening.*) They are ready.

Mr. DRAWBAUGH (at transmitter). There are a number of insulated wires hanging against the wall.

Mr. HEIGES (at telltale). "There are a number of insulated wires against the wall."

Mr. HILL (*to Mr. Drawbaugh*). Make the sentence short, so they will repeat it back right. They don't repeat it exactly when it is so long.

Mr. DRAWBAUGH. Am I to talk now right along?

Mr. HEIGES. No, not right along. You ask a short sentence, and if they repeat it, then we will get another.

Mr. DRAWBAUGH (at transmitter). "There are three beds in this room."

Mr. HEIGES (at telltale). "There are three beds in this room."

Mr. DRAWBAUGH (at transmitter). There is also two short-hand writers in the room.

Mr. HEIGES (at telltale). "Repeat."

Mr. DRAWBAUGH (at transmitter). There are also two short-hand writers in this room.

Mr. DICKERSON. Twenty-seven minutes.

Mr. HEIGES (at telltale). "There are two short-hand writers in this room.

Mr. HILL. Say "Mr. Dickerson has just sat down."

Mr. DRAWBAUGH (at transmitter). Mr. Dickerson has just sat down.

Mr. HEIGES (at telltale). "Mr. Dickerson has just sat down."

Mr. [illegible]. Jacobs is walking the floor of this room."

Mr. [illegible]GH (at transmitter). Mr. Jacobs is walking the floor of this room.

Mr. [illegible]GES (at elltale). "Mr. Jacobs is walking on the floor of this room."

Mr. HILL. "Mr. Ernest Marx is standing near the door."

Mr. DRAWBAUGH (at transmitter). Mr. Ernest Marx is standing near the door.

Mr. HEIGES (at telltale). "Mr. Ernest Marx is standing near the door."

Mr. HILL. "Mr. Pope is sitting on the lounge."

Mr. DRAWBAUGH (at transmitter). Mr. Pope is sitting on the lounge.

Mr. HEIGES (at telltale). Repeat that.

Mr. DRAWBAUGH (at transmitter). Mr. Pope is sitting on the lounge.

Mr. DICKERSON (*to the stenographers*). Twenty-nine minutes.

Mr. HEIGES (at telltale). "Mr. Pope is sitting on the lounge."

Mr. DRAWBAUGH (at transmitter). There is a table before me which I am resting upon.

Mr. HEIGES (at telltale). "Repeat; not quite so loud."

Mr. DRAWBAUGH (at transmitter). There is a table before me which I am resting upon.

Mr. HEIGES (at telltale). "There is a table before me which I am resting upon."

Mr. DRAWBAUGH (at transmitter). There is a telephone cord laying on this table.

Mr. DICKERSON (*to stenographers*). Thirty minutes.

Mr. HEIGES (at telltale). "There is a telephone coach laying on this table."

Mr. DRAWBAUGH (at transmitter). Telephone cord.

Mr HEIGES (at telltale). "Telephone cord."

Mr. HILL. "It is a very pleasant day."

Mr. DRAWBAUGH (at transmitter). It is a very pleasant day.

Mr. HEIGES (at telltale). "It is a very pleasant day."

Mr. HILL. "Washington is one hundred and forty miles fr Philadelphia."

Mr. DRAWBAUGH (at transmitter). Washington is one hundre and forty miles from Philadelphia.

Mr. HEIGES (at telltale). "Washington is one hundred and fort miles from Philadelphia."

Mr. HILL. "The Atlantic Ocean is three thousand miles wide."

Mr. DRAWBAUGH (at transmitter). The Atlantic Ocean is thre thousand miles wide.

Mr. HEIGES (at telltale). "The Atlantic Ocean is three thousand miles wide."

Mr. HILL. "Boston is the capital of Massachusetts."

Mr. DRAWBAUGH (at transmitter). Boston is the capital of Massachusetts.

Mr. HEIGES (at telltale). "Boston is the capital of Massachusetts."

Mr. DRAWBAUGH (at transmitter). Now, I think I will allow Mr. Hill to take the transmitter. (*To Mr. Hill*). Now, Judge, you take it.

Mr. HILL. Wait and see if he gets that.

Mr. HEIGES (at telltale). "Now I think I will allow Mr. Hill to take the transmitter."

[*Mr. Hill here takes the place of Mr. Drawbaugh, in front of the transmitter.*]

Mr. HEIGES (at telltale). What do you say? (*Listening.*) Are you ready? (*Listening*). "Ready."

Mr. HILL (at transmitter). Professor Barker, do you hear me now?

Mr. HEIGES (at telltale). "Professor Barker, do you hear me now?"

Mr. HILL (at transmitter). Do you distinguish the difference between my voice and that of Mr. Drawbaugh?

Mr. HEIGES (at telltale). "Do you distinguish — " I can't repeat that. Please give me that again, Mr. Marx. (*Listening.*) "Do

you distinguish the difference between my voice and that of Mr. Lawbaugh?" "Yes, perfectly."

Mr. HILL (*to the stenographers*). Note that the trouble was on the telltale line, and not on the test line there.

Mr. HEIGES. The trouble was the forgetfulness of me, really in hearing.

Mr. HILL (at transmitter). How is the articulation of this instrument now?

Mr. HEIGES (at telltale). "How is the articulation of this instrument now?" "Very good."

Mr. HILL (at transmitter). How plainly can you hear what I say?

Mr. HEIGES (at telltale). "How plainly can you hear what I say?" "Perfectly."

Mr. HILL (at transmitter). When did you leave the university to-day?"

Mr. HEIGES (at telltale). "When did you leave the university to-day?" "A quarter of two."

Mr. HILL (at transmitter). Did you deliver a lecture before you left?

Mr. HEIGES (at telltale). "Did you deliver a lecture before you left?" "Yes."

Mr. HILL (at transmitter). How many students had you present at your lecture?

Mr. HEIGES (at telltale). "How many students had you present at your lecture?" "Between eighty and ninety."

Mr. HILL (at transmitter). What was the subject of the lecture?

Mr. HEIGES (at telltale). "What was the subject of the lecture?" (*Listening.*) I did'nt get that; hold on.

Mr. DICKERSON (*to the stenographers*). Thirty-five minutes.

Mr. HEIGES (at telltale). Repeat the subject. (*Listening.*) Repeat what the subject was. I missed it. (*Listening.*) I didn't get you yet. (*Listening.*) I haven't got it yet. You get a little too close, when you talk; it blurrs it too much for me. Please

repeat again. (*Listening.*) I got all except what the lecture wa on. That I didn't get. (*Listening.*) I didn't get what he lectu on; I didn't get that. You speak too quick. Give me time to g it to my ear, will you, please? Give me time, when I speak to yo to get the receiver to my ear, will you, please? Now give me wha the lecture was, will you, please — what it was on? (*Listening.* "Yes, sir." (*Listening.*) (*To Mr. Hill.*) It is strange that he and I can't understand. It is young Marx. He asks me if we are ready, and then I haven't got it. We can get it by going over to find out.

Mr. HILL. Wait a moment.

Mr. MARX, Sen. here enters the room, and says "polarization."

Mr. HILL (*to Mr. Marx*). "Polarization." You couldn't get it?

Mr. MARX. We got it.

Mr. HILL. But he could not get it through the telephone.

Mr. HEIGES (at telltale). Are you ready? (*Listening.*) "All ready. Go ahead."

Mr. HILL (at transmitter). Now, Professor, do you hear me?

Mr. HEIGES (at telltale). "Now, Professor, do you hear me?"

Mr. HILL (at transmitter). Your lecture was on polarization, was it?

Mr. HEIGES (at telltale). "Your lecture was on polarization, was it?"

Mr. HILL (at transmitter). I should like to have been present and heard it.

Mr. HEIGES (at telltale). "I should like to have been present and heard it."

Mr. HILL (at transmitter). Was it on the polarization of light?

Mr. HEIGES (at telltale). "Was it on the polarization of light?"

Mr. HILL (at transmitter). Will you tell me who discovered the polarization of light, and its cause?

Mr. HEIGES (at telltale). "Can you tell me who discovered the

olarization of light, and its cause?" (*To Mr. Hill.*) It is most long for me to repeat; I am afraid I lost some.

Mr. HILL (at transmitter). This case will be tried before Judge cKennon and Judge Butler.

Mr. HEIGES (at telltale). "This suit will be tried before Judge ennon and Butler."

Mr. HILL (at transmitter). Mr. Drawbaugh is now sitting near the bed in this room.

Mr. HEIGES (at telltale). "Mr. Drawbaugh is now sitting near the bed in this room."

Mr. HILL (at transmitter). Did you illustrate your lecture by any experiments on the polarization of light?

Mr. HEIGES (at telltale). "Did you illustrate your lecture by any experiments on the polarization of light?"

Mr. HILL (at transmitter). Chestnut street is one of the finest streets in Philadelphia.

Mr. HEIGES (at telltale). "Chestnut street is one of the finest streets in Philadelphia."

Mr. Hill (at transmitter). Does this instrument still hold its adjustment well?

Mr. HEIGES (at telltale). "Does this instrument still hold its adjustment well?"

Mr. HILL (at transmitter). Mr. Storrow is in your room, is he t?

Mr. HEIGES (at telltale). "Mr. Storrow is in your room, is he ot?"

Mr. Hill (at transmitter). Professor Cross is there with him, is he not?

Mr. HEIGES (at telltale). "Professor Cross is there with him, is he not?"

Mr. HILL (at transmitter). And there is a stenographer present in the room, on the part of the Bell Company, is there not?

Mr. HEIGES (at telltale). "There is a stenographer present in the room, is he not, on the part of the Bell Company?"

Mr. HILL (at transmitter). It is said that General Gordon has either been captured or killed,

Mr. HEIGES (at telltale). "It is said that General Gordon has either been captured or killed,"

Mr. HILL (at transmitter). and that the position of the Brit army in Egypt is very precarious.

Mr. HEIGES (at telltale). "and that the position of the Britis army in Egypt is very precarious."

Mr. HILL (at transmitter). Professor Barker, suppose I read you something from a newspaper?

Mr. HEIGES (at telltale). "Professor Barker, suppose I read you something from a newspaper?"

Mr. HILL (*to Mr. Heiges*). Is there any answer to that?

Mr. HEIGES. Yes, he did it while I was talking. (At telltale). Please give your answer to that again. Give me the answer to that question. (*Listening.*)

Mr. OTT. I suggest that for convenience in printing, you mention the Paper first. It might cause confusion, when you get to printing the testimony.

Mr. HEIGES (at telltale). "Just wait a minute."

Mr. HILL (at transmitter). Are you ready now?

Mr. HEIGES (at telltale). "Are you ready now?"

Mr. HILL (at transmitter). I will read an article from the Philadelphia *Press* of this morning, Feb. 6.

Mr. HEIGES (at telltale). "I will read an article from the *Press* of this morning, Feb. 6."

Mr. HILL (at transmitter). "Atlanta, Ga., Feb. 5."

Mr. HEIGES (at telltale). "Atlanta, Ga., Feb. 5."

Mr. HILL (at transmitter). "Hon. Thomas A. Hendricks and party —"

Mr. HEIGES (at telltale). "Hon. Thomas A. Hendricks and party—"

Mr. HILL (at transmitter). "reached Atlanta this morning at four o'clock,—"

Mr. HEIGES (at telltale). "reached Atlanta this morning at four o'clock,—"

Mr. HILL (at transmitter). "in a special car."

Mr. HEIGES (at telltale). "in a special car."

Mr. HILL (at transmitter). "At half past eight —"

Mr. HEIGES (at telltale). "At half past eight — "

Mr. HILL (at transmitter). "they were escorted to the Kimball House, — "

Mr. HEIGES (at telltale). "they were escorted to the Kimball House,— "

Mr. HILL (at transmitter). "where breakfast was served."

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). "where breakfast was served."

Mr. HEIGES (at telltale). "Again."

Mr. HILL (at transmitter). where breakfast was served."

Mr. HEIGES (at telltale). "where breakfast was served."

Mr. HILL (at transmitter). "The company they met at breakfast—"

Mr. HEIGES (at telltale). The company assembled at breakfast—"

Mr. HILL (at transmitter). "The company they met at breakfast—"

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). "The company they met at breakfast—"

Mr. HEIGES (at telltale). "The company they met at breakfast—"

Mr. HILL (at transmitter). "consisted of about thirty prominent citizens"

Mr. HEIGES (at telltale). "consisted of about thirty prominent citizens."

Mr. HILL (at transmitter). "A large crowd was congregated about the hotel."

Mr. HEIGES (at telltale). "A large crowd was congregated about the hotel.

Mr. HILL (at transmitter). "The mayor introduced Mr. Hendricks—"

Mr. HEIGES (at telltale). "The mayor introduced Mr. Hendricks—"

Mr. HILL (at transmitter). "who addressed the people from the balcony."

Mr. HEIGES (at telltale). "who addressed the people from the balcony."

Mr. HILL (at transmitter). "After the speaking—"

Mr. HEIGES (at telltale). "After the speaking—"

Mr. HILL (at transmitter). "the ladies were driven around the city—"

Mr. HEIGES (at telltale). "the ladies were driven around the city—"

Mr. HILL (at transmitter). "and the gentlemen proceeded to the hall of the house of representatives,—"

Mr. HEIGES (at telltale). "and the gentlemen proceeded to the hall of the house of representatives,—"

Mr. HILL (at transmitter). "where a reception was held,—"

Mr. HEIGES (at telltale). "where a reception was held, —"

Mr. HILL (at transmitter). "and several hundred persons —"

Mr. HEIGES (at telltale). "and several hundred persons —"

Mr. HILL (at transmitter). "were presented to the vice-president elect."

Mr. HEIGES (at telltale). "were presented to the vice-president elect."

Mr. HILL (at transmitter). "The party left for Birmingham —"

Mr. HEIGES (at telltale). "The party left for Birmingham —"

Mr. HILL (at transmitter). "at ten o'clock, —"

Mr. HEIGES (at telltale). "at ten o'clock, —"

Mr. HILL (at transmitter). "and will proceed from there —"

Mr. HEIGES (at telltale). "and will proceed from there —"

Mr. HILL (at transmitter). "to the New Orleans Exposition."

Mr. HEIGES (at telltale). "to the New Orleans Exposition."

Mr. HILL (at transmitter). "Much enthusiasm —"

Mr. HEIGES (at telltale). "Much enthusiasm —"

Mr. HILL (at transmitter). "was manifested over Mr. Hendricks."

Mr. HEIGES (at telltale). "was manifested over Mr. Hendricks."

Mr. HILL (at transmitter). That is the end of the article.

Mr. HEIGES (at telltale). "That is the end of the article."

Mr. HILL (at transmitter). What receiver have you now on the line, at your end?

Mr. HEIGES (at telltale). "What receiver have you now on the line, at your end?" (*Listening.*) What? (*Listening.*) Did

you say "E_2"? (*Listening.*) I can't get you right. You get too close when you speak. (*Listening.*) I have it, now; "B_2". (*Listening.*) "The second letter of the alphabet and the second letter of the numerals." So I was right; "B_2".

Mr. HILL (at transmitter). You say you have receiver "B_2". Is that correct?

Mr. HEIGES (at telltale). "You say you have receiver "B_2". Is that correct?"

Mr. HILL (at transmitter). All right. I will now remove this instrument, "F_2". No, wait a moment.

Mr. HEIGES (at telltale). "All right. I will now remove this instrument, "F_2".

Mr. HILL (at transmitter). No, I have changed my mind; I will not remove it.

Mr. HEIGES (at telltale). "No, I have changed my mind; I will not remove it."

Mr. HILL (at transmitter). But I will ask you to remove your receiver.

Mr. HEIGES (at telltale). "But I will ask you to remove your receiver.

Mr. HILL (at transmitter). And to substitute one of the receivers of the form known as "I."

Mr. DICKERSON. 55 minutes.

Mr. HEIGES (at telltale). "And to substitute one of the receivers of the form known as 'I.'"

Mr. HILL (at transmitter). When you have done it, I will resume.

Mr. HEIGES (at telltale). "I was not listening. Please repeat."

Mr. HILL (at transmitter). When you have done that, I will resume.

Mr. HEIGES (at telltale). "If you have done that, I will resume."

Mr. HILL (to Mr. Heiges). Ask him if he is making the change.

Mr. HEIGES (at telltale). Are you making the change? (*Listening.*) All right. He says they will make it in a moment.

Mr. Hill (at transmitter). Are you ready?

Mr. HEIGES (at telltale). "Yes, we are ready, are you?" Go ahead.

Mr. HILL (at transmitter). Now, Professor Barker, do you hear me?

Mr. HEIGES (at telltale). "Now, Professor Barker, do you hear me?" "Yes, very well."

Mr. HILL (at transmitter). "Do you hear me any more plainly than you did with the receiver 'B$_2$'?"

Mr. HEIGES (at telltale). "Do you hear me any more plainly than you did with the receiver 'B$_2$'?"

Mr. HILL (at transmitter). "Please answer back whether you do or do not?"

Mr. HEIGES (at telltale). "Please answer back whether you do or do not." "Yes, I hear you just as distinctly now, and a little louder."

Mr. HILL (at transmitter). Suppose, now, I read you an article from the newspaper.

Mr. HEIGES (at telltale). "Suppose, now, I read you an article from the newspaper."

Mr. HILL (at transmitter). Are you ready? Please answer back."

Mr. HEIGES (at telltale). "Are you ready? Please answer back." "Yes."

Mr. HILL (at transmitter). I will read another article from this morning's Philadelphia *Press*.

Mr. HEIGES (after listening at telltale). The Professor was not listening. You will have to repeat that.

Mr. HILL (at transmitter). I will read another article from this morning's Philadelphia *Press*.

Mr. HEIGES (at telltale). "I will read another article from this morning's Philadelphia *Press*."

Mr. HILL (at transmitter). It is entitled "Hearty Endorsement of General Logan,—"

Mr. HEIGES (at telltale). "It is entitled 'Hearty Endorsement of General Logan,'—"

Mr. DICKERSON (*to the stenographers*). Four o'clock.

Mr. HILL (at transmitter). and is copied from the New York *Independent*."

Mr. HEIGES (at telltale). "and is copied from the New York *Independent*."

Mr. HILL (at transmitter). It is as follows:

Mr. HEIGES (at telltale). "It is as follows:"

Mr. HILL (at transmitter). "We sincerely desire the re-election—"

Mr. HEIGES (at telltale). "We sincerely desire the re-election—"

Mr. HILL (at transmitter). "to the United States Senate—"

Mr. HEIGES (at telltale). "to the United States Senate—"

Mr. HILL (at transmitter). "of General John A. Logan of Illinois,—"

Mr. HEIGES (at telltale). "of General John A. Logan of Illinois,—"

Mr. HILL (at transmitter). "who has been a very useful and true man,—"

Mr. HEIGES (at telltale). "who has been a very useful and true man,—"

Mr. HILL (at transmitter). "has done good service to his country,—"

Mr. HEIGES (at telltale). has done good service to his country,—"

Mr. HILL (at transmitter). "as a soldier,—"

Mr. HEIGES (at telltale). "as a soldier,—"

Mr. HILL (at transmitter). "and is greatly respected in Congress."

Mr. HEIGES (at telltale). "and is greatly respected in Con-Mss."

Mr. HILL (at transmitter). "He has the entire confidence—"

A Mr. HEIGES (at the telltale). "He has the entire confidence—"

Mr. HILL (at transmitter). "of the Republican party—"

Mr. HEIGES (at telltale). "of the Republican party—"

Mr. HILL (at transmitter). "and of the people generally—"

Mr. HEIGES (at telltale). "and of the people generally—"

Mr. HILL (at transmitter). "both in and out of the State—"

Mr. HEIGES (at telltale). "both in and out of the State—"

Mr. HILL (at transmitter). "he now so ably represents—"

Mr. HEIGES (at telltale). "who now so ably represents—"

Mr. HILL (at transmitter). "he now so ably represents — "

Mr. HEIGES (at telltale). "who now so ably represents — "

Mr. HILL (at transmitter). No, not "*who*," — "*he*."

Mr. HEIGES (at telltale). "No, not '*who*,' — '*he*.' "

Mr. HILL (at transmitter). "he now so ably represents, — "

Mr. HEIGES (at telltale). "he now so ably represents, — "

Mr. HILL (at transmitter). "and he doubtless will have, — "

Mr. HEIGES (at telltale). "and he doubtless will have, — "

Mr. HILL (at transmitter). "as he deserves to have, — "

Mr. HEIGES (at telltale). "as he deserves to have, — "

Mr. HILL (at transmitter). "the solid vote — "

Mr. HEIGES (at telltale). "the solid vote — "

Mr. HILL (at transmitter). "of all the republicans — "

Mr. HEIGES (at telltale). "of all the republicans — "

Mr. HILL (at transmitter). "of the legislature of Illinois — "

Mr. HEIGES (at telltale). "of the legislature of Illinois — "

Mr. HILL (at transmitter). "to secure his return to the senate."

Mr. HEIGES (at telltale). "to secure his return to the senate."

Mr. HILL (at transmitter). That is the end of the article.

Mr. HEIGES (at telltale). "That is the end of the article."

Mr. HILL (at transmitter). And I cordially endorse what it says.

Mr. HEIGES (at telltale). "And I cordially endorse what it says."

Mr. HILL (at transmitter). Although Mr. Drawbaugh would probably take the opposite side.

Mr. HEIGES (at telltale). "My friend Drawbaugh would probably take the opposite side."

Mr. HILL (at transmitter). Now I will remove instrument "F[illegible]

Mr. HEIGES (at telltale). "Now I will remove instrument 'F_2'.

Mr. HILL (at transmitter). And substitute another form of "F" instrument, —

Mr. HEIGES (at telltale). "And substitute another form of F instrument, — "

Mr. HILL (at transmitter). which has the carbon box supported by two rods or wires.

Mr. HEIGES (at telltale). "which has the carbon box supported by two rods or wires."

Mr HILL (at transmitter). The one I have been using—

Mr. HEIGES (at telltale). "The one I have been using — "

Mr. HILL (at transmitter). "had the carbon box supported by a single rod."

Mr. HEIGES (at telltale). "had the carbon box supported by a single rod."

Mr. HILL (*to Mr. Ott, the examiner*). Mr. Ott, as I have concluded this test, I put that instrument in your hands.

Mr. DICKERSON. We want to look at that before we go away.

Mr. OTT. You don't want to go away yet.

Mr. DICKERSON Presently, when the other one is tried.

Mr. OTT. I will take them and put them in my trunk, in my room.

[*Mr. Hill removes the tumbler instrument "F," and substitutes a tumbler instrument marked "F_1."*]

Mr. HILL (*to Mr. Heiges*). Ask him if they are ready.

Mr. HEIGES (at telltale). Are you ready? (*Listening.*) Hello! (*Listening.*) Yes, we are ready if you are. Are you ready? (*Listening.*) "Yes, ready."

Mr. HILL (at transmitter). Hello! Professor Barker. Do you hear me?

Mr. HEIGES (at telltale). "Professor, do you hear me?"

Mr. HILL (at transmitter). How is the adjustment?

Mr. HEIGES (at telltale). "How is the adjustment?"

Mr. HILL (at transmitter). Please answer back how it is.

Mr. HEIGES (I didn't understand you. The question was "How is that?" The answer is "Better."

Mr. HILL (at transmitter). I asked, how is the adjustment?"

Mr. HEIGES (at telltale). "I asked how is the adjustment." Answer. "Not good."

Mr. HILL (at transmitter). Is it too loud or too weak?

Mr. HEIGES (at telltale). "Is it too loud or too weak?" Answer, "Too loud."

Mr. HILL (at transmitter). I commenced to use it without adjusting it.

Mr. HEIGES (at telltale). "I commenced to use it without adjusting it."

Mr. HILL (at transmitter). I took it out of the box —

Mr. HEIGES (at telltale). "I took it out of the box —"

Mr. HILL (at transmitter). and affixed it to the line —

Mr. HEIGES (at telltale). "and I fixed it to the line —"

Mr. HILL (at transmitter). "just as it was."

Mr. HEIGES (at telltale). "just as it was."

Mr. HILL (at transmitter). But I will now adjust it a little —

Mr. HEIGES (at telltale). "But I will now adjust it a little —"

Mr. HILL (at transmitter). if you think it will work better.

Mr. HEIGES (at telltale). "if you think it will work better."

Mr. HILL (at transmitter). What do you think about it?

Mr. HEIGES (at telltale. "What do you think about it?" Answer. "I think the articulation might be improved."

Mr. HILL (at transmitter). Well, how is it now?

Mr. HEIGES (at telltale). "Well, how is it now?" Answer, "Very weak."

Mr. HILL (at transmitter). I have changed it a little. How is it now?

Mr. HEIGES (at telltale). "I have changed it a little. How is it now?" Answer, "Good, as to loudness, but the articulation is not so good."

Mr. HILL (at transmitter). Perhaps I spoke a little too loud into it. How is it now?

Mr. HEIGES (at telltale). "Perhaps I spoke a little too loud into it. How is it now?" "Better."

Mr. HILL (at transmitter). I spoke too loud, I suppose.

Mr. HEIGES (at telltale). "I spoke too loud, I suppose."

Mr. HILL (at transmitter). Do you think you could hear a newspaper article now?

Mr. HEIGES (at telltale). "Do you think you could hear a newspaper article now?" Answer, "yes."

Mr. HILL (at transmitter). I will read you something again from this morning's *Press*.

Mr. HEIGES (at telltale). "I will read you something again from this morning's *Press*."

Mr. HILL (at transmitter). "Washington, February 5."

Mr. HEIGES (at telltale). "Washington, February 5."

Mr. HILL (at transmitter). "There were quite a number of absentees, —"

Mr. HEIGES (at telltale). "There were quite a number of absentees,—"

Mr. HILL (at transmitter). "on the democratic side —"

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). "on the democratic side —"

Mr. HEIGES (at telltale). "on the democratic side —"

Mr. HILL (at transmitter). "of both the house and senate chambers —"

Mr. HEIGES (at telltale). "of both the house and senate chambers —"

Mr. HILL (at transmitter). "this morning, —"

Mr. HEIGES (at telltale). "this morning, —"

Mr. HILL (at transmitter). "and the invariable answer was —"

Mr. HEIGES (at telltale). "and the invariable answer was —"

Mr. HILL (at transmitter). "when a senator or representative could not be found —"

Mr. HEIGES (at telltale). "when a senator or representative could not be found —"

Mr. HILL (at transmitter). "Gone to see Cleveland."

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). "Gone to see Cleveland."

Mr. HEIGES (at telltale). What do you say? You will have to repeat again.

Mr. HILL (at transmitter). "Gone to see Cleveland."

Mr. HEIGES (at telltale). "Gone to see Cleveland."

Mr. HILL (at transmitter). "Several of the gentlemen —"

Mr. HEIGES (at telltale). "Several of the gentlemen —"

Mr. HELL (at transmitter). "who have been contemplating visits to the President-elect, —"

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). "who have been contemplating visits to the President-elect."

Mr. HEIGES (at telltale). "Repeat a little louder."

MR. HILL (at transmitter). "who have been contemplating visits to the President-elect."

Mr. HEIGES. No use. The adjustment is bad.

Mr. HILL (at transmitter). Well, let us adjust it, then, a moment.

Mr. HEIGES (at telltale). "Very weak."

Mr. HILL (at transmitter). How is it now?

Mr. HEIGES (at telltale). "How is it now?" "Better, if you will talk lower."

Mr HILL (at transmitter). Now, how is it?

Mr. HEIGES (at telltale). "Now, how is it?" "Good, but speak a little lower."

Mr. HILL (at transmitter). Very well. I will resume the newspaper article where I left off. Do you get that?

Mr. HEIGES (at telltale). "Now, I will resume the newspaper article where I left off.

Mr. HILL (at transmitter). Are you ready?

Mr. HEIGES. Hold on. He said something to me and I didn't get it. (At transmitter). What did you say? (*Listening.*) Answer, "No, adjust it a little closer."

Mr. HILL (at transmitter). Well, how is it now? Do you get it any plainer?

Mr. HEIGES (at telltale). "How is it now? Do you get it any plainer?" "No; very weak."

Mr. HILL (at transmitter). How is it now?

Mr. HEIGES (at telltale). "How is it now?" "Very good."

Mr. HILL. Well, is it good now, still?

Mr. HEIGES (at telltale). "Well, is it now good still?" Answer, "Yes."

Mr. HILL (at transmitter). Shall I resume the newspaper article now?

Mr. HEIGES (at telltale). "Shall I resume the newspaper article now?" "Yes, but talk a little lower."

Mr. HILL (at transmitter). "Several of the gentlemen —"

Mr. HEIGES (at telltale). "Several of the gentlemen —"

Mr. HILL (at transmitter). "who have been contemplating visits to the President-elect, —"

Mr. HEIGES (at telltale). "who have been contemplating visits to the President-elect, —"

Mr. HILL (at transmitter). "upon the published notice that he would be at home — "

Mr. HEIGES (at telltale). "upon the published notice that he would be at home — "

Mr. HILL (at transmitter). "to all persons desiring to talk with him — "

Mr. HEIGES (at telltale). "to all persons desiring to talk with him — "

Mr. HILL (at transmitter). "regarding governmental business, — "

Mr. HEIGES (at telltale). "regarding governmental business, —"

Mr. HILL (at transmitter). "were surprised to learn — "

Mr. HEIGES (at telltale). "were surprised to learn — "

Mr. HILL (at transmitter). "that special invitations — "

Mr. HEIGES (at telltale). "that special invitations — "

Mr. HILL (at transmitter). "had been extended — "

Mr. HEIGES (at telltale). "had been extended — "

Mr. HILL (at transmitter). "to a majority of the senators, — "

Mr. HEIGES (at telltale). "to a majority of the senators,"

Mr. HILL (at transmitter). "and quite a number of the more prominent representatives."

Mr. HEIGES (at telltale). "and quite a number of the more prominent representatives."

Mr. HILL (at transmitter). "This fact, however, — "

Mr. HEIGES (at telltale). "This fact, however, — "

Mr. HILL (at transmitter). "is intended in no way — "

Mr. HEIGES (at telltale). "is intended in no way — "

Mr. HILL (at transmitter). "to preclude others from calling upon Cleveland."

Mr. HEIGES (at telltale). "to preclude others from calling upon Cleveland."

Mr. HILL (at transmitter). "Those who have had invitations — "

Mr. HEIGES (at telltale). "Those who have had invitations — "

Mr. HILL (at transmitter). "understood that their visit — "

Mr. HEIGES (at telephone). "understood that their visit — "

Mr. HILL (at transmitter). "is primarily to make the acquaintance of the President-elect, — "

Mr. HEIGES (at telltale). "is primarily to make the acquaintance of the President-elect, —"

Mr. HILL (at transmitter). "and discuss with him —"

Mr. HEIGES (at telltale). "and to talk with him —"

Mr. HILL (at transmitter). "discuss with him —"

Mr. HEIGES (at telltale). "and discuss with him —"

Mr. HILL (at transmitter). "matters of legislative and executive policy,"

Mr. HEIGES (at telltale). "matters of legislative and executive policy, —"

Mr. HILL (at transmitter). "rather than to give advice —"

Mr. HEIGES (at telltale). "rather than to give advice —"

Mr. HILL (at transmitter). "as to the selection of a cabinet."

Mr. HEIGES (at telltale). "as to the selection of a cabinet."

Mr. HILL (at transmitter). "The more prominent visitors, however, —"

Mr. HEIGES (at telltale). "The more prominent visitors, however, —"

Mr. HILL (at transmitter). "will not hesitate to give Mr. Cleveland —"

Mr. HEIGES (at telltale). "will not hesitate to give Mr. Cleveland —"

Mr. HILL (at transmitter). "their views regarding cabinet appointments,—"

Mr. HEIGES (at telltale). "their views regarding cabinet appointments, —"

Mr. HILL (at transmitter). "their views regarding cabinet appointments, —"

Mr. HEIGES (at telltale). "their views regarding cabinet appointments, —"

Mr. HILL (at transmitter). "and the friends of Mr. McDonald,—"

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). "and the friends of Mr. McDonald,—"

Mr. HEIGES (at telltale). "and the friends of Mr. McDonald, —"

Mr. HILL (at transmitter). "Mr. Barber,—"

Mr. HEIGES (at telltale). "Mr. Barber, —"

Mr. HILL (at transmitter). "Mr. Money,—"

Mr. HEIGES (at telltalle). "Repeat."

Mr. HILL (at transmitter). "Mr. Money, —"

Mr. HEIGES (at telltale). "Mr. Many, —"

Mr. HILL (at transmitter). "Money" — M-o-n-e-y,—

Mr. HEIGES (at telltale). "M-a-n-e-y,—"

Mr. HILL (at transmitter). "M-o-n-e-y, —"

Mr. HEIGES (at telltale). "M-o-n-e-y,—"

Mr. HILL (at transmitter). Mr. Money,—

Mr. DICKERSON (*looking at his watch*). 4.28.

Mr. HEIGES (at telltale). "Mr. Money, —"

Mr. HILL (at transmitter). "Mr. Stockton, —"

Mr. HEIGES (at telltalle). "Mr. Hopkins, —"

Mr. HILL (at transmitter). "Stockton, —"

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter) "Stockton."

Mr. HEIGES (at telltale). What do you say? (*Listening.*) "Repeat again."

Mr. HILL (at transmitter). "Stockton," S-t-o-c-k-t-o-n.

Mr. HEIGES (at telltale). "S-t-a-c-k-t-o-n."

Mr. HILL (at transmitter). "S-t-o-c-k."

Mr. HEIGES (at telltale). "S-t-a-c-k."

Mr. HILL (at transmitter). "o," not "a."

Mr. HEIGES (at telltale). "o," not "a."

Mr. HILL (at transmitter). "Stockton—Mr. Stockton and others, —"

Mr. HEIGES (at telltale). "Mr. Stockton and others—"

Mr. HILL (at transmitter). "will tell Mr. Cleveland —"

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). "will tell Mr. Cleveland —"

Mr. HEIGES (at telltale). "will tell Mr. Cleveland —"

Mr. HILL (at transmitter). "why they think —"

Mr. HEIGES (at telltale). "why they think —"

Mr. HILL (at transmitter). "he should choose those gentlemen —"

Mr. HEIGES (at telltale). "he should choose those gentlemen —"

Mr. HILL (at transmitter). "for posts at the executive board."

Mr. HEIGES (at telltale). "for posts on the executive board."

Mr. HILL (at transmitter). That is the end of the article, Professor.

Mr. HEIGES (at telltale). "That is the end of the article, Professor."

Mr. HILL (at transmitter). How is the adjustment now?

Mr. HEIGES (at telltale). "How is the adjustment now!" Ans. "Very good."

Mr. HILL (at transmitter). I have not adjusted it since I commenced to read the article —

Mr. HEIGES (at telltale). "I have not adjusted it since I commenced to read the article —"

Mr. HILL (at transmitter). "the second time,—"

Mr. HEIGES (at telltale). "the second time, —"

Mr. HILL (at transmitter). and have held it in my hand all the time.

Mr. HEIGES (at telltale). "I have held it in my hand all the time."

Mr. HILL (at transmitter). What receiver have you now on your end of the line?

Mr. HEIGES (at telltale). "What receiver have you now on your end of the line?" Answer, "I_1."

Mr. HILL (at transmitter). Now, will you please remove "I_1" and substitute an instrument of the "B" form?

Mr. HEIGEL (at telltale). I didn't get you right that time. You have got to come more plain. (*Listening.*) "Now, will you remove I and substitute one of the B form?"

Mr. HILL (at transmitter). Answer back, please.

Mr. HEIGES (at telltale). What do you say? (*Listening.*) "Repeat."

Mr. HILL (at transmitter). What receiver have you now on?

Mr. HEIGES (at telltale). "What receiver have you now on?" Answer, "B_2."

Mr. HILL (at transmitter). How is the articulation with these two instruments?

Mr. HEIGES (at telltale). "How is the articulation with this instrument?"

Mr. HILL (at transmitter). With these two instruments.

Mr. HEIGES (at telltale). "The articulation is good, but it is weak."

Mr. HILL (at transmitter). I will adjust it a little, then.

Mr. HEIGES (at telltale). "We will have it adjusted a little, then."

Mr. HILL (at transmitter). How is it now?

Mr. HEIGES (at telltale). "How is it now?" Answer, "Much better."

Mr. HILL (at transmitter). Is it well enough adjusted now?

Mr. HEIGES (at telltale). "Is it well enough adjusted now?"

Mr. HILL (at transmitter). Please answer back.

Mr. HEIGES (at telltale). "Please answer back." (*Listening.*) What do you say (*Listening.*) Please repeat that to me, Mr. Marx, will you? (*Listening.*) Answer, "It is in fair adjustment now."

Mr. HILL (at transmitter). Well, what time do you get your dinner generally?

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). What time do you get your dinner?

Mr HEIGES (at telltale). "What time do you generally go to dinner?"

Mr. HILL (at transmitter). It is now twenty-five minutes of five.

Mr. HEIGES (at telltale). "It is now twenty-five minutes of five."

Mr. HILL (at transmitter). I will talk to you a little, to try the "B" receiver,—

Mr. HEIGES (at telltale). "I will talk to you a little, to try the 'B' receiver,—"

Mr. HILL (at transmitter). in order to test that instrument.

Mr. HEIGES (at telltale). "in order to test that instrument."

Mr. HILL (at transmitter). How do you get the sound now?

Mr. HEIGES (at telltale). "How do you get the tone now?" Answer, "Very well."

Mr. HILL (at transmitter). This is a very pleasant day.

Mr. HEIGES (at telltale). "This is a very pleasant day." [illegible]"

Mr. HILL (at transmitter). Washington is 120 miles from Harrisburg.

Mr. HEIGES (at telltale). "Washington is 120 miles from Harrisburg."

Mr. HILL (at transmitter). I will count a few irregular numbers.

Mr. HEIGES (at telltale). "I will count a few irregular numbers."

Mr. HILL (at transmitter). 1, 5, 10, 24.

Mr. HEIGES (at telltale). "1, 5, 10, 24."

Mr. HILL (at transmitter). 29, 33, 37, 40.

Mr. HEIGES (at telltale). "29, 33, 37, 40."

Mr. HILL (at transmitter). 45, 54, 68.

Mr. HEIGES (at telltale). "45, 57, 68."

Mr. HILL (at transmitter). 74, 81, 93.

Mr. HEIGES (at telltale). "74, 81, 93."

Mr. HILL (at transmitter). 114, 135, 160.

Mr. HEIGES (at telltale). "113, 125, 150."

Mr. HILL (at transmitter). 113, 135, 160.

Mr. HEIGES (at telltale). "113, 125, 150."

Mr. HILL (at transmitter). 135.

Mr. HEIGES (at telltale). "135."

Mr. HILL (at transmitter). 160.

Mr. HEIGES (at telltale). "150."

Mr. HILL (at transmitter). 60.

Mr. HEIGES (at telltale). "60"

Mr. HILL (at transmitter). 210.

Mr. HEIGES (at telltale). "210."

Mr. HILL (at transmitter). 320.

Mr. HEIGES (at telltale). "330."

Mr. HILL (at transmitter). 20.

Mr. HEIGES (at telltale). "20."

Mr. HILL (at transmitter). 901.

Mr. HEIGES (at telltale). "401."

Mr. HILL (at transmitter). 901.

Mr. HEIGES (at telltale). "901."

Mr. HILL (at transmitter). 1876.

Mr. HEIGES (at telltale). "1876."

Mr. HILL (at transmitter). 1885.

Mr. HEIGES (at telltale). "1885."

Mr. HILL (at transmitter). How does the adjustment of this instrument hold out?

Mr. HEIGES (at telltale). "How does the adjustment of this instrument hold out?" Answer, "Very good."

Mr. HILL (at transmitter). I have not adjusted it since I began to read the newspaper article the second time, if I remember aright.

Mr. HEIGES (at telltale). "I have not adjusted it since I began to read the newspaper article the second time."

Mr. HILL (at transmitter). I will now remove this instrument, and substitute an instrument of the "C" form.

Mr. HEIGES (at telltale). "I will now remove this instrument, and put on an instrument of the 'C' form."

Mr. HILL (at transmitter). Are you ready?"

Mr. HEIGES. Wait a minute. They will be ready soon.

Mr. HILL (at transmitter). Hello! Hello!

Mr. HEIGES. Hold on a minute, and I will tell you.

Mr. HILL (*to Mr. Heiges*). Tell him to put on instrument I.

Mr. HEIGES (at telltale). Put on instrument "I" at your end. (*Listening.*) He says it is hard work, and the Professor is getting tired. We will be ready in a minute.

Mr. HILL (*to Mr. Heiges*). Ask him if he is ready now.

Mr. HEIGES (at telltale). Ready now? (*Listening.*) "All right. Ready."

Mr. HILL (at transmitter). Hello! Do you hear me now?

Mr. HEIGES (at telltale). "Hello! Do you hear me now?" Answer, "Yes."

Mr. HILL (at transmitter). Well, how plainly do you hear me?

Mr. HEIGES (at telltale). "Well, how plainly do you hear e?" Answer, "Distinctly, but not very loud."

Mr. HILL (at transmitter.) Are you getting tired of listening, rof. Barker?

Mr. HEIGES (at telltale). "Are you getting tired of listening, Prof. Barker?" "Yes, I am —" The last word I missed (*Listening*). All right (*to Mr. Hill*). Go ahead.

Mr. HILL (at transmitter). Now, are you all ready again?

Mr. HILL (at transmitter). "Now are you all ready again? Answer, "Yes."

Mr. HILL (at transmitter). Mr. Drawbaugh and Mr. Jacobs are both standing up.

Mr. HEIGES (at telltale). "Mr. Drawbaugh and Mr. Jacobs are both standing up."

Mr. HILL (at transmitter). Mr. Dickerson is examining the instrument "F" which we just used.

Mr. HEIGES (at telltale). "Mr. Dickerson is examining the instrument 'F'."

Mr. HILL (at transmitter). And has already taken it apart.

Mr. HEIGES (at telltale). "And has already taken it apart."

Mr. HILL (at transmitter). Mr. Pope and another gentleman are examining it with him.

Mr. HEIGES (at telltale). "Mr. Pope and another gentleman a examining it with him."

Mr. HILL (at transmitter). It is now ten minutes of five.

Mr. HEIGES (at telltale). "It is now ten minutes of five."

Mr. HILL (at transmitter). And I will put this test through rapidly as possible.

Mr. HEIGES (at telltale). "And I will put this test through rapidly as possible."

Mr. HILL (at transmitter). General Grant is said to be quite ill.

Mr. HEIGES (at telltale). "General Grant is said to be quite ill."

Mr. HILL (at transmitter). He is affected with a trouble of the throat, —

Mr. HEIGES (at telltale). "He is afflicted with a trouble of throat —"

Mr. HILL (at transmitter). caused by an excessive use tobacco.

Mr. HEIGES (at telltale). "caused by an excessive use tobacco."

Mr. HILL (at transmitter). And Mr. Drawbaugh, —

Mr. HEIGES (at telltale). "And Mr. Drawbaugh, —"

.. HILL (at transmitter). as soon as he just heard me say s —

Mr. HEIGES (at telltale). "And Mr. Drawbaugh —"

Mr. HILL (at transmitter). when he just heard me say this, —

Mr. HEIGES (at telltale). "when he just heard me say this, —"

Mr. HILL (at transmitter). threw his tobacco away.

Mr. HEIGES (at telltale). "threw his tobacco away."

Mr. HILL (at transmitter). Mr. Ott, the examiner, is quite im-tient.

Mr. HEIGES (at telltale). "Mr. Ott, the examiner, is looking —"

Mr. HILL (at transmitter). is looking quite impatient; —

Mr. HEIGES (at telltale). "quite impatient; —"

Mr. HILL (at transmitter). and he says that the reason of it —

Mr. HEIGES (*listening*). The professor says you shall repeat.

Mr. HILL (at transmitter). And Mr. Ott says that the reason it is —

Mr. HEIGES (at telltale). "and says that the reason of it is, —"

Mr. HILL (at transmitter). that he has the toothache.

Mr. HEIGES (at telltale). "that he has the toothache."

Mr. HILL (at transmitter). I don't wonder at his impatience, if ch is the case.

Mr. HEIGES (at telltale). "I don't wonder at his impatience, if ch is the case."

Mr. HILL (at transmitter). I have been talking through a "C" strument —

Mr. HEIGES (at telltale). "I have been talking through the 'C' strument —"

Mr. HILL (at transmitter). with a battery on the line.

Mr. HEIGES (at telltale). "with a battery on the line."

Mr. HILL (at transmitter). I will now have Mr. Heiges remove on the battery.

Mr. HEIGES (at telltale). "I will now have Mr. Heiges remove battery."

[*Mr. Heiges does so.*]

Mr. HILL (at transmitter). Hello, professor!

Mr. HEIGES (at telltale). "Hello, professor!"

Mr. HILL (at transmitter). Do you hear me now?

Mr. HEIGES (at telltale). "Do you hear me now?"

Mr. HILL (at transmitter). Can you hear as plainly as you diare with the battery on?

Mr. HEIGES (at telltale). "Can you hear as plainly as you diar with the battery on?" Answer, "Yes."

Mr. HILL (at transmitter). I had Mr. Heiges remove the bat in erry.

Mr. HEIGES (at telltale). "I had Mr. Heiges remove the bat in tery."

Mr. HILL (at transmitter). "I have got tired of talking, and will let Mr. Drawbaugh take my place awhile.

Mr. HEIGES (at telltale). "I have got tired of talking, and w will let Mr. Drawbaugh take my place awhile."

[*Mr. Drawbaugh takes the place of Mr. Hill in front of the instr ment to be tested.*]

Mr. HILL (*to Mr. Drawbaugh*). Call him first, and see if h gets you.

Mr. DRAWBAUGH (at transmitter). Professor Barker, are yo now ready?

Mr. HEIGES (at telltale). "Professor Barker, are you all ready? (*Listening.*) What do you say? (*Listening.*) The Professo says the question was asked in Mr. Drawbaugh's voice.

Mr. DRAWBAUGH (at transmitter). Judge Hill is now walkir the floor.

Mr. HEIGES (at telltale). "Repeat, please."

Mr. DRAWBAUGH (at transmitter). Judge Hill is now walkin t the floor.

Mr. HEIGES (at telltale). "Judge Hill is now walkin of floor."

Mr. DRAWBAUGH (at transmitter). I suppose he is tired.

Mr. HEIGES (at telltale). "Repeat."

Mr. DRAWBAUGH (at transmitter). I suppose he is tired.

Mr. HEIGES (at telltale). "Again."

Mr. DRAWBAUGH (at transmitter). I suppose he is tired.

Mr. HEIGES (at telltale). "I suppose he is tired."

Mr. DRAWBAUGH (at transmitter). I will now give you a little of the old talk we had at the shop.

Mr. HEIGES (at telltale). "Repeat."

Mr. DRAWBAUGH (at transmitter). I will now give you a little of the talk that we had at my shop.

Mr. HEIGES (at telltale). "Repeat again."

Mr. DRAWBAUGH (at transmitter). I will now give you a little of the old talk that we had at my shop. (*To Mr. Heiges.*) Tell him to wait.

Mr. HEIGES (at telltale). Just wait a moment.

[*Mr. Drawbaugh adjusts the instrument.*]

Mr. DRAWBAUGH (at transmitter). Professor, I have now adjusted it a little.

Mr. HEIGES (at telltale). Are you ready? (*Listening*). "Ready now?"

MR. DRAWBAUGH (at transmitter). I have changed the adjustment a little. Does it seem any better now?

Mr. HEIGES. "I have changed the adjustment a little. Does it seem any better now?" Ans. "Yes, a trifle better."

Mr. DRAWBAUGH (at transmitter). Harrisburg is situated on the banks of the Susquehanna River, in the State of Pennsylvania.

Mr. HEIGES. I can't repeat such a long sentence as that. Don't make them too long. I can't repeat. (*Listening.*)

Mr. DRAWBAUGH (at transmitter). Harrisburg is situated on the banks of the Susquehanna River.

Mr. HEIGES (at telltale). "Again."

Mr. DRAWBAUGH (at transmitter). Harrisburg is situated on the banks of the Susquehanna River.

Mr. HEIGES (at telltale). I don't understand that.

Mr. DRAWBAUGH (at transmitter). I said Harrisburg is situated on the east bank of the Susquehanna River.

Mr. HEIGES (at telltale). I cannot get it.

Mr. HILL. Ask him how he hears that.

Mr. DRAWBAUGH (at transmitter). Professor, how do you hear now? Do you get my words plainly, or not?

[*Mr. Marx, Sen., here enters the room.*]

Mr. MARX. It is getting dark in there. They have sent for lights.

Mr. HILL. Are they waiting?

Mr. MARX. They are waiting.

Mr. HEIGES (at telltale). We are ready now? (*Listening.*)

Mr. DRAWBAUGH (at transmitter). Professor, what instrument do you have at your end of the line?

Mr. HEIGES (at telltale). "Professor, what instrument do you have at your end of the line?" (*Listening.*) He says I shall hold on and he will give the answer. (*Listening.*) Can you tell me what receiver you have there at that end? (*Listening.*) Yes, we are all ready. Go along. You did not give the answer. We did not get the answer of what instrument is on your end. (*Listening.*) "The instrument 'I' is on our end now as a receiver."

Mr. DRAWBAUGH (at transmitter). Are you ready now?

Mr. HEIGES (at telltale). We are all ready. (*Listening.*) We will speak to you now. (*Listening.*) "All right, go ahead."

Mr. DRAWBAUGH (at transmitter). Now, Professor, I will count you some numbers. 1, 2, 3, 4.

Mr. HEIGES (at telltale). "Professor, I will count you some numbers. 1, 2, 4."

Mr. DRAWBAUGH (at transmitter). 3, 7, 9, 12.

Mr. HEIGES (at telltale). "8, 11, 9, 12."

Mr. DRAWBAUGH (at transmitter). 17, 14, 21.

Mr. HEIGES (at telltale). "17, 14, 21." (*To Mr. Drawbaugh.*) You put them too far apart. He begins to tell me them back before you get through. Put them closer together, or not so many, so we don't get any tangling up.

Mr. DRAWBAUGH (at transmitter). 11, 16, 15.

Mr. HEIGES (at telltale). Now, he just missed that one because you put them too far apart. Listen to me, Dan. You said "11," then you stopped awhile, and then he commenced to answer back again.

Mr. DRAWBAUGH (at transmitter). 11, 15, 21.

Mr. HEIGES (at telltale). "11, 15, 31."

Mr. DRAWBAUGH (at transmitter). 42, 73, 40.

Mr. HEIGES (at telltale). "17, 23, 40."

Mr. Drawbaugh (at transmitter). I am now getting tired.

Mr. Heiges (at telltale). "I am now getting tired."

Mr. Drawbaugh (at transmitter). I will leave some one else speak.

Mr. Heiges (at telltale). "I will leave some one else to speak."

Mr. Drawbaugh (at transmitter). Professor, you please ask Judge Hill if we haven't enough of this kind of talk.

Mr. Heiges (at telltale). "Professor, please ask Judge Hill if he hasn't a —" Please repeat the rest.

Mr. Drawbaugh (at transmitter). Enough of this kind of talk.

Mr. Heiges (at telltale). "Don't get it. Speak louder."

Mr. Drawbaugh (at transmitter). Enough of this kind of talk.

Mr. Heiges (at telltale). Hello! I am waiting for the answer. (*Listening.*) He says, "Are you ready to go on?" "Go ahead."

Mr. Drawbaugh (at transmitter). You did not answer the full question.

Mr. Heiges (at telltale). "Please repeat."

Mr. Drawbaugh (at transmitter). I said, you did not answer the question in full, — the last question.

Mr. Heiges (at telltale). "Can't get it. Repeat."

Mr. Drawbaugh (at transmitter). You did not answer the full question, — the last question.

Mr. Heiges (at telltale). I think there must be a misunderstanding between us about that question. There was part of that question not answered, and part of it was answered. (*Listening.*) I said there must be a misunderstanding between us now. The question that Mr. Drawbaugh asked was not all answered; part of it was answered and part was not. (*Listening.*) "Tell him to ask the question again." (*To Mr. Drawbaugh.*) Now you ask him again. You say in there "this kind of talk."

Mr. Drawbaugh (at transmitter). Now, that was not the question.

Mr. Dickerson. You asked him if we had not got enough of this kind of talk.

Mr. Heiges. What you said was, "Please ask Judge Hill whether he has not got enough of this kind of talk."

Mr. Drawbaugh (at transmitter). Are you ready now?

Mr. HEIGES (*listening*). Yes. Give the question.

Mr. DRAWBAUGH (at transmitter). You please ask Judge Hill if we have not enough of this kind of talk.

Mr. HEIGES (at telltale). "Please ask Judge Hill if we have not got a new kind of talk."

Mr. DRAWBAUGH (at transmitter). Enough of this kind of talk—enough.

Mr. HEIGES (at telltale). Professor Barker says he don't get the last words. Just say "enough."

Mr. DRAWBAUGH (at transmitter). enough of this kind of talk.

Mr. HEIGES (at telltale). "if he has not had enough of this kind of talk."

Mr. DRAWBAUGH (at transmitter). Is Ernest Marx over in that room?

Mr. HEIGES (at telltale). Hello! (*Listening.*) (*To Mr. Drawbaugh.*) I am to ask you how you are feeling. Tell them through there how you are feeling.

Mr. DRAWBAUGH (at transmitter). I am feeling pretty warm. I am close to a hot stove.

Mr. HEIGES (at telltale). "I am feeling pretty warm. I think I will have to go."

Mr. DRAWBAUGH (at transmitter). I said, I am near a hot stove.

Mr. HEIGES (at telltale). "I have a cold."

Mr. DRAWBAUGH (at transmitter). I said I am near a hot stove.

Mr. HEIGES (at telltale). "Repeat."

Mr. DRAWBAUGH (at transmitter). I am near a hot stove.

Mr. HEIGES (at telltale). "Repeat again."

Mr. DRAWBAUGH (at transmitter). I am near a hot stove.

Mr. HEGIES (at telltale). "Don't get it."

Mr. DRAWBAUGH (at transmitter). Well, I can't make it any plainer.

Mr. HEIGES (at telltale). What did you say? (*Listening.*) I didn't get what you said to me. (*To Mr. Drawbaugh.*) He said something that you should do, and I suppose he just laid the receiver down and walked away.

[*Mr. Hill here enters the room.*]

Mr. HILL (*to Mr. Drawbaugh*). Did you put on another instrument "C"?

Mr. DRAWBAUGH. No.

Mr. HILL. I told you, through the telltale.

Mr. HEIGES. I know there was something said, and I said, I couldn't get him.

[*Mr. Drawbaugh adjusts the instrument.*]

Mr. HILL (*To Mr. Heiges*). Call through the telltale.

Mr. HEIGES (at telltale). Are you ready? (*Listening.*) Hello! hello! (*Listening.*) The time is short. They ought to attend to their business, and be taught afterwards. (At telltale). Hello! hello! (*Listening.*) We are ready any time you are. (*Listening.*) Ready, Dan?

Mr. HILL (*to Mr. Drawbaugh*). Ask him if he hears.

Mr. DRAWBAUGH (at transmitter). Professor Barker, do you hear me now?

Mr. HEIGES (at telltale). "Professor Barker, do you hear me now?"

Mr. DRAWBAUGH (at transmitter). We have changed an instrument—put on another "C" instrument.

Mr. HEIGES (at telltale). "We have changed the instrument—put on another "C" instrument."

Mr. DRAWBAUGH (at transmitter). Judge Hill is now walking the floor of this room.

Mr. HEIGES (at telltale). "Repeat."

Mr. DRAWBAUGH (at transmitter). Judge Hill is now walking the floor of this room.

Mr. HEIGES (at telltale). "Judge Hill is now walking the floor of this room."

Mr. DRAWBAUGH (at transmitter). M. W. Jacobs is sitting on a bed in this room.

Mr. HEIGES (at telltale). "And Mr. Jacobs is sitting on the bed in this room."

Mr. HILL (*to Mr. Drawbaugh*). "Harrisburg is the capital of Pennyslvania."

Mr. DRAWBAUGH (at transmitter). "Harrisburg is the capital of Pennyslvania."

Mr. HEIGES (at telltale). "Harrisburg is the capital of Pennsylvania."

Mr. DRAWBAUGH (at transmitter). It is situated on the east bank of the Susquehanna river.

Mr. HEIGES (at telltale). "Situated on the east bank of the Susquehanna river."

Mr. DRAWBAUGH (at transmitter). I see a number of overcoats lying on one of these beds.

Mr. HEIGES (at telltale). "I see a number of overcoats lying on these beds."

Mr. DRAWBAUGH (at transmitter). Also a number of hats.

Mr. HEIGES (at telltale). "Also a number of hats."

Mr. DRAWBAUGH (at transmitter). Now, I think I shall allow Judge Hill to take the instrument again.

Mr. HEIGES (at telltale). Now I will give this to Judge Hill, and let him speak in it.

Mr. DRAWBAUGH (at transmitter). That is not exactly what I said.

Mr. DICKERSON. It is the same idea.

[*Mr. Hill here takes the place of Mr. Drawbaugh in front of the instrument to be tested.*]

Mr. HILL (at transmitter). Hello, Professor Barker.

Mr. HEIGES (at telltale). "Hello, Professor Barker."

Mr. HILL (at transmitter). How plainly do you hear me?

Mr. HEIGES. "How plainly do you hear me?" "Very well."

Mr. HILL (at transmitter). Are you getting tired, and ready to quit soon?

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). Are you getting tired, and ready to quit soon?

Mr. HEIGES (at telltale). "Are you getting tired, and ready to quit soon?"

Mr. HILL (at transmitter). How is that lamp over there? Has there been any more explosion?

Mr. HEIGES (at telltale). "Repeat. I was not listening."

Mr. HILL (at transmitter). How is that lamp over in your room? Has there been another explosion?

Mr. HEIGES (at telltale). "How is that lamp in your room?

Has there been another explosion?" "We are expecting another explosion."

Mr. HILL (at transmitter). That lamp is worse than dynamite.

Mr. HEIGES (at telltale). "That lamp is made of dynamite."

Mr. HILL (at transmitter). I said it was worse than dynamite.

Mr. HEIGES (at telltale). "I said it was worse than dynamite."

Mr. HILL (at transmitter). The British lion would turn his tail, and run away from it.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). I said the British lion would turn tail, and run away from it.

Mr. HEIGES (at telltale). "The British lion" is all we got here.

Mr. HILL (at transmitter). The British lion would turn tail and run away from that lamp.

Mr. Heiges (at telltale). "would turn tail away before that lamp.

Mr. HILL (at transmitter). Do you know where Governor Cleveland is to-day?

Mr. HEIGES (at telltale). "Do you know where Governor Cleveland is to-day?"

Mr. HILL (at transmitter). I want to ask him to appoint me to an office.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). I want to ask him to appoint me to an office.

Mr. HEIGES "Again."

Mr. HILL (at transmitter). I said I want to ask him to appoint me to an office.

Mr. HEIGES (at telltale). "I said I would like to ask him to appoint me to an office."

Mr. HILL (at transmitter). But I don't believe he would do it.

Mr. HEIGES (at telltale). "But I don't believe he would do it."

Mr. HILL (at transmitter). Have you any idea who his cabinet will be?

Mr. HEIGES (at telltale). "Have you any idea who his cabinet will be?"

Mr. HILL (at transmitter). I don't expect a cabinet appointment myself.

Mr. HEIGES (at telltale). "I don't expect a cabinet appointment myself."

Mr. HILL (at transmitter). But I hope he will make a good one when he makes one.

Mr. HEIGES (at telltale). "But I hope he will make some good ones when he makes them."

Mr. HILL (at transmitter). The Atlantic Ocean is three thousand miles wide.

Mr. HEIGES (at telltale). "The Atlantic Ocean is three thousand miles wide."

Mr. HILL (at transmitter). The sun is about ninety-five millions of miles from the earth.

Mr. HEIGES (at telltale). "The sun is about ninety-four million miles from the earth."

Mr. HILL (at transmitter). The moon is about two-hundred and forty thousand miles from the earth.

Mr. HEIGES (at telltale). "The moon is about two hundred and forty thousand miles from the earth."

Mr. HILL (at transmitter). How many students in the law class were examined at the university the other day?

Mr. HEIGES (at transmitter). "How many students were examined in the law class at the University the other day?"

Mr. HILL (at transmitter). Now, Professor Barker, will you remove the instrument "I"?

Mr. HEIGES (at telltale). "Repeat that now."

Mr. HILL (at transmitter. Prof. Barker, will you remove the instrument "I"?

Mr. HEIGES (at telltale). "Repeat it again."

Mr. HILL (at transmitter). Prof. Barker, will you remove the instrument "I"?

Mr. HEIGES (at telltale). "Professor Barker, will you remove the instrument 'I'?"

Mr. HILL (at transmitter). Well, you need not remove it just yet.

Mr. HEIGES (at telltale). "Again."

Mr. HILL (at transmitter). I said you need not remove it just yet.

Mr. HEIGES. "Again."

Mr. HILL (at transmitter). I said you need not remove it just yet.

Mr. HEIGES (at telltale). "I said you need not remove it just yet."

Mr. HILL (at transmitter). I want to talk a little more before you remove it.

Mr. HEIGES (at telltale). "I want to talk a little more before you remove it."

Mr. HILL (at transmitter). I think I was talking too loud into this transmitter.

Mr. HEIGES (at telltale). "I think I was taking too loud into this transmitter."

Mr. HILL (at transmitter). You seem to hear me more plainly now, do you not?

Mr. HEIGES (at telltale). "You seem to hear me more plainly, now, do you not?" "I hear you very well."

Mr. HILL (at transmitter). It has been a pleasant day, and is a very pleasant evening.

Mr. HEIGES (at telltale). "It has been a very pleasant day, and is a very pleasant evening."

Mr. HILL (at transmitter). The sky seems to be entirely clear of clouds.

Mr. HEIGES (at telltale). "The sky seems to be entirely clear of clouds."

Mr. HILL (at transmitter). The air is crisp and cool.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). The air is crisp and cool.

Mr. HEIGES (at telltale). "The air is crisp and cool."

Mr. HILL (at transmitter). A great many pretty girls were on the street this afternoon, —

Mr. HEIGES (at telltale). "And a great many pretty girls were on the street this afternoon, —"

Mr. HILL (at transmitter). but I had no time to stop and admire them.

Mr. HEIGES (at telltale). "but I had no time to stop and admire them."

Mr. HILL (at transmitter). Perhaps that fact had something to do with your being so late.

Mr. HEIGES (at telltale). "Perhaps that might have had something to do with your being so late."

Mr. HILL (at transmitter). I do not blame anybody for stopping to look along the street on such a day.

Mr. HEIGES (at telltale). Marx, just give me that answer again. I didn't get it right. (*Listening.*) "I don't blame any body for stopping to look along the street—"

Mr. HILL (at transmitter). On such a day.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). "On such a day."

Mr. HEIGES (at telltale). "Again."

Mr. HILL (at transmitter). On such a day.

Mr. HEIGES (at telltale). "On such a day."

Mr. HILL (at transmitter). Now, I will speak considerably lower than I have been speaking. How do you get that?

Mr. HEIGES (at telltale). "Now, I will speak considerably lower than I have been speaking. How do you get that?" Answer, "Very well."

Mr. HILL (at transmitter). Well, now I will speak lower still. How do you get that?

Mr. HEIGES (at telltale). "Now, I am speaking lower still. How do you get that?" Answer, "Better than before."

Mr. HILL (at transmitter). Then I must have been speaking too loud in the early part of the experiments.

Mr. HEIGES (at telltale). "Then I have been speaking too loud in the early part of the experiments.

Mr. HILL (at transmitter). "How is the articulation of this instrument?"

Mr. HEIGES (at telltale). "How is the articulation of this instrument?"

Mr. HILL (at transmitter). You get me all right now, don't you?

Mr. HEIGES (at telltale). "You get met all right now, don't you." Ans. "Yes."

Mr. HILL (at transmitter). I can just see the top of Mr. Marx's head through the window.

Mr. HEIGES (at telltale). "I can just see the top of Mr. Marx's head through the window." Ans. "Then" — the last word I missed Give it to me again. (*Listening.*) "Full moon." Did you say "full moon?" (*Listening.*) "Yes."

Mr. HILL (at transmitter). Well, I am not responsible for calling it a full moon. I suppose Mr. Marx did that.

Mr. HEIGES (at telltale). "I suppose Mr. Marx did that." Repeat the first part of the sentence.

Mr. HILL (at transmitter). I said I am not responsible for calling it a full moon.

Mr. HEIGES (at telltale). "I am not responsible for him looking like a full moon."

Mr. HILL (at transmitter). When do you want to return to your house, Professor Barker?

Mr. HEIGES (at telltale). "When do you want to return to your house, Professor Barker?" Ans. "I return at six."

Mr. HILL (at transmitter). It is now a quarter of six.

Mr. HEIGES (at telltale). "It is now a quarter of six."

Mr. HILL (at transmitter). I will ask you to take off that instrument "I."

Mr. HEIGES (at telltale). "I will ask you to take off that instrument 'I'."

Mr. HILL (at transmitter). And put on an instrument of the "B" form.

Mr. HEIGES (at telltale). "And put on an instrument of the "C" form."

Mr. HILL (at transmitter). "B" — "B" form.

Mr. HEIGES (at telltale). "On the 'B' form."

Mr. HILL (at transmitter). "And I will put on the battery here.

Mr. HEIGES (at telltale). "And I will put on the battery here"

Mr. HILL (at transmitter). Are you ready now to make the change?

Mr. HEIGES. "Are you ready now to make the change?" Ans "Yes."

Mr. HILL (at transmitter). "All right; go ahead."

[*Mr. Hill and Mr. Drawbaugh adjust the instrument.*]

Mr HILL (at telltale). I will speak as soon as we get the battery on. Now, are you ready.

Mr. HEIGES (at telltale). Ready, now.

Mr. HILL (at transmitter). Hello! Prof. Barker.

Mr. HEIGES (at telltale). They must not be listening.

Mr. HILL (at transmitter). Hello! Prof. Barker.

Mr. HEIGES (at telltale). Are you listening? (*To Mr. Hill.*) I didn't get anything yet. Ask them again.

Mr. HILL (at transmitter). Hello! hello! Prof. Barker.

Mr. HEIGES. Hold on a minute.

[*Mr. Hill, Mr. Drawbaugh and Mr. Heiges examine the wires.*]

Mr. HEIGES (at telltale). Now, are you ready? (*Listening.*) "Will be ready in a minute." (*Listening.*) "Now, ready, go on."

Mr. HILL (at transmitter). Hello! Prof. Barker. Hello! hello!

Mr. HEIGES (at telltale). Do you hear anything?

Mr. HILL (*To Mr. Drawbaugh*). Dan, you go over there and see if the poles of that instrument "B" are in contact. They may not be in contact.

Mr. HEIGES (at telltale). What do you say? Have you got our instrument on? (*Listening*). "No. 2."

Mr. HILL (*To the stenographers*). Line No. 2. Put it down.

Mr. HEIGES (at telltale). All ready now.

Mr. HILL (at transmitter). Hello! hello!

Mr. HEIGES (at telltale). "Hello!"

Mr. HILL (at transmitter). Do you hear me now?

Mr. HEIGES (at telltale). "Do you hear me now."

Mr. HILL (at transmitter). What was the matter over there?

Mr. HEIGES (at telltale). "What was the matter wiih the line?"

Mr. HILL (at transmitter). Was your instrument out of adjustment?

Mr. HEIGES (at telltale). "Repeat. Very faint."

Mr. HILL (at transmitter). Was your instrument out of adjustment?

Mr. HEIGES (at telltale). "Was your instrument out of adjustment?"

Mr. HILL (at transmitter). Dan Drawbaugh has just returned from your room.

Mr. HEIGES (at telltale). "Dan Drawbaugh has just returned from your room.

Mr. HILL (at transmitter). No, I was mistaken; it was not Dan Drawbaugh, it was another gentleman.

Mr. HEIGES (at telltale). "No, I was mistaken; it is not Dan Drawbaugh, it is another gentleman."

Mr. HILL (at transmitter). Now, there he comes.

Mr. HEIGES (at telltale). "Repeat it."

Mr. HILL (at transmitter). Now, there he comes.

Mr. HEIGES (at telltale). "Now, Dan is coming."

Mr. HILL (at transmitter). He has just come in at the door.

Mr. HEIGES. "He has just come in the door."

Mr. HILL (at transmitter). The instruments that are now on the line.

Mr. HEIGES (at telltale). "The instruments that are now on the line."

Mr. HILL (at transmitter). Are an instrument of the form of "C" at this end?

Mr. HEIGES (at telltale). "An instrument of the form of "C" at this end."

Mr. HILL (at transmitter). And an instrument of the form of "B" at your end."

Mr. HEIGES (at telltale). "And an instrument of the form of "B" at your end."

Mr. HILL (at transmitter). With a battery in line.

Mr. HEIGES (at telltale). "With a battery in line."

Mr. HILL (at transmitter). You hear perfectly well what I say, do you not?

Mr. HEIGES (at telltale). "You hear perfectly well what I say, do you not?"

Mr. HILL (at transmitter). Suppose I give you a little geogra phy.

Mr. HEIGES (at telltale). Hold on. What do you say? I did not have the receiver to my ear quick enough when you went to give me an answer. Now answer me again, will you, please? (*Listening.*) "It is weak, but distinct."

Mr. HILL (at transmitter). Do you want a little geography.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). Do you want a little geography?

Mr. HEIGES (at telltale). "Again."

Mr. HILL (at transmitter). Do you want a little geography — the names of some places?

Mr. HEIGES (at telltale). "Again."

Mr. HILL (at transmitter). Perhaps I am speaking too loud; I will speak lower.

Mr. HEIGES (at telltale). "Perhaps I am speaking too loud." "Better."

Mr. HILL (at transmitter). How is it now?

Mr. HEIGES (at telltale). "Hello! How is it now?"

Mr. HILL (at transmitter). Do you get me any better now than when I spoke loud.

Mr. HEIGES (at telltale). "Do you get me any better now?"

Mr. HILL (at transmitter). Do you get me any better now than when I spoke loud?

Mr. HEIGES (at telltale). "Do you get it any better now than when I spoke loud."

Mr. HILL (at transmitter). What do you think about it?

Mr. HEIGES (at telltale). "What do you think about it." Ans. "Yes, I do."

Mr. HILL (at transmitter). Well, then I will speak lower hereafter.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). Well, then I will speak lower hereafter.

Mr. HEIGES (at telltale). Hold on a minute! (*Listening.*) Go on now.

Mr. HILT (at transmitter). Well, do you hear me now?

Mr. HEIGES (at telltale). He was not listening; I think Marx was talking to me.

Mr. HILL (at transmitter). I say, Professor, do you hear me now?

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). Hello! hello!. Do you hear me now?

Mr. HEIGES (at telltale). "Hello! hello!" There is something wrong with the instrument, I guess.

Mr. HILL (at transmitter). Do you hear me now? I am speaking very low.

Mr. HEIGES (at telltale). "Do you hear me now." "Very low."

Mr. HILL (at transmitter). I will speak lower still. Do you hear me now?

Mr. HEIGES (at telltale). "I will speak lower still. Do you hear me now?" "Yes."

Mr. HILL (at transmitter). Do you hear me any better now?

Mr. HEIGES (at telltale). "Is that any better now?"

Mr. HILL (at transmitter). How does the instrument compare with Exhibit "I"?

Mr. HEIGES (at telltale). "How does the instrument compare with instrument 'I'?"

Mr. HILL (at transmitter). Well, it is nearly six o'clock; are you ready to stop?

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). It is now nearly six o'clock. Are you ready to stop?

Mr. HEIGES (at telltale). "It is now most six o'clock; are you ready to stop?" "Yes."

Mr. HILL (at transmitter). Ready and anxious.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). Ready and anxious."

Mr. HEIGES (at telltale). "Again."

Mr. HILL (at transmitter). I said, are you ready and anxious to stop?

Mr. HEIGES (at telltale). "Are you ready or not ready to stop.' Answer, "I am ready."

Mr. HILL (at transmitter). Very well, we will say just a few words more, and then stop.

Mr. HEIGES (at telltale). "Again."

Mr. HILL (at transmitter). Very well, we will say just a few words more, and then stop.

Mr. HEIGES (at telltale). "All right. We will once more do something, and then we will stop."

Mr. HILL (at transmitter). We will say a few words more.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). Say a few words more.

Mr. HEIGES (at telltale). "Again."

Mr. HILL (at transmitter). We will say a few words more.

Mr. HEIGES (at telltale). "We will say a few words more, and then stop."

Mr. HILL (at transmitter). Yes. I was speaking too loud again; I do it involuntarily.

Mr. HEIGES (at telltale). "Can't hear. It is too faint."

Mr. HILL (at transmitter). I said I was speaking too loud again.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). I said I was speaking too loud again.

Mr. HEIGES (at telltale). What do you say? Repeat again. Don't get quite so close.

Mr. HILL (at transmitter). I said I was speaking too loud again

Mr. HEIGES (at telltale). Hold on a minute.

[*Mr. Drawbaugh adjusts the instrument.*]

Mr. HEIGES (at telltale). All ready.

Mr. HILL (at transmitter). Hello! hello!

Mr. HEIGES (at telltale). "Hello!"

Mr. HILL (at transmitter). Do you hear me now more plainly?

Mr. HEIGES (at telltale). "Do you hear me now more plainly?'

Mr. HILL (at transmitter). The pole had stuck against the armature.

Mr. HEIGES (at telltale). "Repeat."

Mr. HILL (at transmitter). I said the pole in this machine had stuck against the armature.

Mr. HEIGES. "Again."

Mr. HILL (at transmitter). I said that the pole of this machine had stuck against the armature.

Mr. HEIGES (at telltale). "The pole of this machine has stuck against the armature."

Mr. HILL (at transmitter). Well, Professor, is it time to go to supper now?

Mr. HEIGES (at telltale). "Professor, is it time to go to supper now?"

Mr. HILL (at transmitter). What do you think about it?

Mr. HEIGES (at telltale). "Yes, I think it is."

Mr. HILL (at transmitter). All right, good-bye.

Mr. HEIGES (at telltale). "Good-bye."

Mr. DICKERSON. Are your experiments through now?

Mr. HILL. The experiments that we make to-day are through now.

Mr. DICKERSON. Are you going to make any more to-morrow?

Mr. HILL. No, not to-morrow.

Mr. DICKERSON. Mr. Drawbaugh, what did you say the powder was — bronze and carbon?

Mr. DRAWBAUGH. Yes. I will look at it.

Mr. DICKERSON. They looked to me as if they were somewhat different.

Mr. DRAWBAUGH. That (*indicating*) is the bronze and carbon.

Mr. DICKERSON. The one-legged one is bronze and carbon?

Mr. DRAWBAUGH. Yes.

Mr. HILL. Plumbago in it?

Mr. DICKERSON. No, no plumbago in it.

Mr. DICKERSON. Bronze and carbon and no plumbago in it. Now, the other one.

Mr. DRAWBAUGH. That has carbon in it.

Mr. DICKERSON. Without any mixture?

Mr. DRAWBAUGH. Without any mixture.

Mr. DICKERSON. The two-legged one has carbon in without any mixture?

Mr. HILL. The instrument with the single stem or rod has the carbon and the bronze. The instrument with the double rod or yoke has the carbon without any admixture.

[*Mr. Hill makes the following statement to go upon the record:* —]

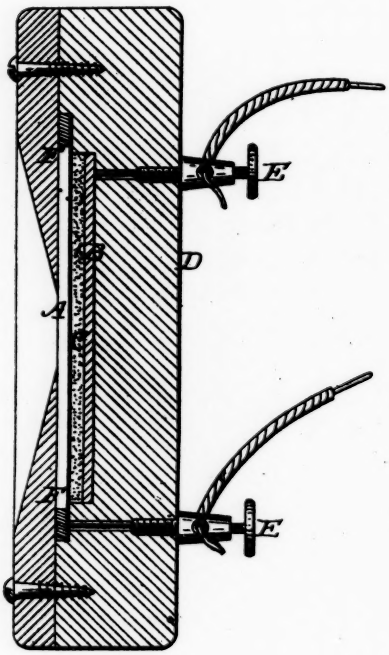
Mr. HILL. Mr. Hill says that the instruments "C" tested here to-day are "C_1," which has been heretofore referred to by Mr. Barker in his testimony; and another instrument which Mr. Barker has not had, but which he will now please to mark. The professor marks the instrument "C_3." There is also present the instrument which Prof. Barker has heretofore referred to in his testimony as "C_2" Mr. Hill states that when he took the instrument "C" out of the bureau drawer here in the room, he did not know which "C" he was using as marked by Prof. Barker, or he would have used "C_2" also, instead of the unmarked instrument. All the instruments that have been tested here to-day, together with this instrument "C_2" are now put into the hands of the examiner, Mr. Ott. The complainants' counsel and expert have taken apart the two tumbler instruments of the form known as "F," and examined them in this room since they were tested this afternoon.

The test being closed, the parties left the room.

H. HUNNINGS.

TRANSMITTER FOR TELEPHONES.

No. 246,512. Patented Aug. 30, 1881.



Witnesses:

E. E. Masson.

Philip Pillsbury

Inventor

Henry Hunnings

by A. Pollok

his attorney

UNITED STATES PATENT OFFICE.

HENRY HUNNINGS, OF ROTHWELL LEEDS, COUNTY OF YORK, ENGLAND.

TRANSMITTER FOR TELEPHONES.

SPECIFICATION forming part of Letters Patent No. 246,512, dated August 30, 1881.

Application filed May 14, 1881. (No model.) Patented in England September 16, 1878.

To all whom it may concern:

Be it known that I, HENRY HUNNINGS, a subject of the Queen of Great Britain, and residing at Rothwell Leeds, in the county of York, England, have invented certain Improvements in and appertaining to Transmitters for Telephones, (for which I have obtained a patent in Great Britain, No. 3,647, dated 16th September, 1878,) of which the following is a specification.

This invention relates to an improved transmitter or battery telephone, which is designed to take the place of the usual transmitting-telephone, and has for its object to increase the loudness and distinctness of the sounds reproduced by the receiving-instrument at the end of the line. It is shown embodied in a compact apparatus that can be freely handed about without liability to be injured. A front vibrating diaphragm, composed wholly or in part of suitable metal—such as platinum, silver, ferrotype-iron, tinned iron, and the like—is employed. In close proximity to the aforesaid vibrating diaphragm is fixed a disk of brass or other suitable metal, and the intervening space is filled with carbon in the form of powder to the depth, say, about one-sixteenth of an inch. The vibrating diaphragm and the fixed disk of brass are connected, respectively, with the opposite poles of a voltaic battery. The whole may be secured in a box of suitable nonconducting material, with a mouth-piece, if desired.

The way in which I prefer to carry my invention into effect is illustrated in the accompanying drawing, showing an enlarged section of the telephone-transmitter. The details can be indefinitely varied, the great feature being in the use of carbon in a state of fine loose powder, not in any way compressed or consolidated, as I find the loose particles of conducting matter to be most delicately sensitive to sonorous vibrations.

Referring to the drawing, A is the vibrating diaphragm, which I make very thin, preferably of platinum-foil, though thin ferrotype-iron, silver, or other metal, or a suitable metal-coated material may be used. It is held in place by the ring F, or in any suitable way, so as to permit it to vibrate freely.

B is the fixed disk or back plate, of brass or other suitable metal.

The intervening space between the diaphragm A and disk B is filled with the loose finely-divided conducting material C. I find the most advantageous result to proceed from the use of oven-made engine-coke, crushed very finely, not ground so as to pulverize (not to shear or tear) the particles, as I find the best results proceed from this. I may, however, use metallized carbon powder prepared with mercury or other suitable metal, if desired.

E E are the binding-screws, placed in connection with the plates A and B.

The above is placed in circuit with a voltaic battery and receiving-telephone of suitable construction—such as Bell's—and the words or other sounds made close to the instrument, or otherwise, will be found to be distinctly and loudly reproduced at the receiving-instrument.

The diaphragm, fixed disk or back plate, and case D might be altered in form, or be made oval or square, or other suitable shape, if desired; but the best results are produced if the instrument is made circular.

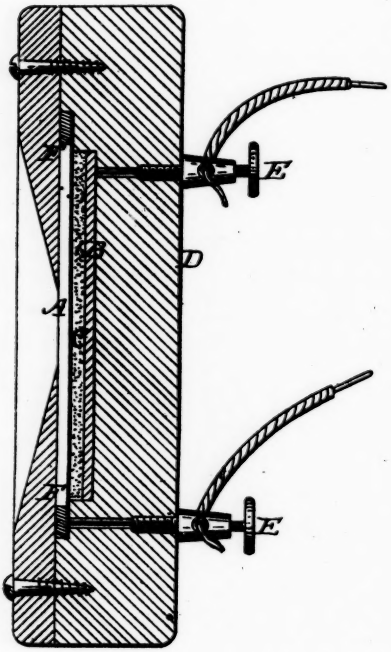
When the instrument is held in the hand at a convenient angle for speaking into it—say inclined from the vertical twenty-five degrees, or thereabout—the weight of the particles generally packs them sufficiently, even if the chamber be not absolutely full, but has a pinch of the material taken out after filling. The handling to which the instrument will be subjected, if used as a hand-instrument, will ordinarily keep the filling in good condition, or, if by accident it becomes too tightly wedged, turning it upside down or striking it with the hand will generally restore it to the proper state.

Having now described my invention and the best mode known to me of carrying it into effect, I would observe, in conclusion, that I do not claim herein, broadly, as a tension regulator or means for varying the resistance in telephonic transmitters, finely-divided conducting material in a loose and free state, nor the combination, with a body of such material, broadly, of a vibratory plate or diaphragm for varying the electrical resistance of said body, not, however, as waiving my right to said matter, but reserving the same for separate application for

H. HUNNINGS.

TRANSMITTER FOR TELEPHONES.

No. 246,512. Patented Aug. 30, 1881.



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B is the fixed disk or back plate, of brass or other suitable metal.

The intervening space between the diaphragm A and disk B is filled with the loose finely-divided conducting material C. I find the most advantageous result to proceed from the use of oven-made engine-coke, crushed very finely, not ground so as to pulverize (not to shear or tear) the particles, as I find the best results proceed from this. I may, however, use metallized carbon powder prepared with mercury or other suitable metal, if desired.

E E are the binding-screws, placed in connection with the plates A and B.

The above is placed in circuit with a voltaic battery and receiving-telephone of suitable construction—such as Bell's—and the words or other sounds made close to the instrument, or otherwise, will be found to be distinctly and loudly reproduced at the receiving-instrument.

The diaphragm, fixed disk or back plate, and case D might be altered in form, or be made oval or square, or other suitable shape, if desired; but the best results are produced if the instrument is made circular.

When the instrument is held in the hand at a convenient angle for speaking into it—say inclined from the vertical twenty-five degrees, or thereabout—the weight of the particles generally packs them sufficiently, even if the chamber be not absolutely full, but has a pinch of the material taken out after filling. The handling to which the instrument will be subjected, if used as a hand-instrument, will ordinarily keep the filling in good condition, or, if by accident it becomes too tightly wedged, turning it upside down or striking it with the hand will generally restore it to the proper state.

Having now described my invention and the best mode known to me of carrying it into effect, I would observe, in conclusion, that I do not claim herein, broadly, as a tension-regulator or means for varying the resistance in telephonic transmitters, finely-divided conducting material in a loose and free state, nor the combination, with a body of such material, broadly, of a vibratory plate or diaphragm for varying the electrical resistance of said body, not, however, as waiving my right to said matter, but reserving the same for separate application for

Letters Patent; and I also wish it to be understood that I do not claim the principle of using carbon in the solid or consolidated form to increase or diminish the resistance of a telephonic circuit for the purpose of transmitting sounds, as this is exemplified in the well-known "Hughes microphone" and the "Edison carbon telephone;" nor do I claim the coating of fibrous or similar surfaces with carbon to produce the same result; but

What I do herein claim as my invention is—

1. As a tension-regulator or means for varying the resistance in telephone-transmitters, finely-divided carbon in a loose and free state, substantially as described.

2. The combination, in a telephone-transmitter, with a body of finely-divided carbon in a loose and free state, of a vibratory plate or diaphragm for varying the electrical resistance of said body in accordance with its own vibrations, substantially as described.

3. A telephone-transmitter comprising a thin metallic or metal-covered diaphragm, a back plate, a layer of finely-divided carbon or similar conducting material in a loose and free state inclosed between said diaphragm and back plate, and a suitable case, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HENRY HUNNINGS.

Witnesses:

JOHN TENNANT,
Solicitor, 18 *Albion Street, Leeds.*

GEORGE TYERS,
18 *Albion Street, Leeds, his clerk.*

ASSIGNMENT HENRY HUNNINGS TO GEORGE L. ANDERS.—HUNNINGS PATENT No. 246,512.

Whereas I, Henry Hunnings, of Rothwell Leeds, in the County of York, England, did obtain Letters Patent of the United States for "Improvements in and appertaining to Transmitters for Telephones," which Letters Patent are numbered 246,512, and bear date the thirtieth day of August, in the year one thousand eight hundred and eighty-one;

And whereas I am now the sole owner of said patent, and of all rights under the same;

And whereas George Lee Anders, of No. 31 Queen Victoria Street, in the City of London, England, is desirous of acquiring the entire interest in the same;

Now therefore, to all whom it may concern, be it known, that for and in consideration of five shillings to me in hand paid, the receipt of which is hereby acknowledged, I, the said Henry Hunnings, have sold, assigned, and transferred, and by these presents do sell, assign, and transfer, unto the said George Lee Anders, the whole right, title, and interest in and to the said improvements in and appertaining to transmitters for telephones, and in and to the Letters Patent therefor aforesaid; the same to be held and enjoyed by the said George Lee Anders for his own use and behoof, and for the use and behoof of his legal representatives, to the full end of the term for which said Letters Patent are, or may be, granted, as fully and entirely as the same would have been held and enjoyed by me had this assignment and sale not been made.

In testimony whereof I have hereunto set my hand and affixed my seal at London, in the County of Middlesex, England, this thirty-first day of August, in the year of our Lord one thousand eight hundred and eighty-one.

H. HUNNINGS.

Signed and sealed in the presence of

D. E. LANGHAM, *Solicitor*,
47 Lincolns Inn Fields, W. C.

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GEORGE L. ANDERS TO AMERICAN BELL TELEPHONE COMPANY. HUNNINGS' PATENT, No. 246,512.

Whereas Henry Hunnings, of Rothwell Leeds, in the county of York, England, did obtain Letters Patent of the United States for "Improvements in and appertaining to Transmitters for Telephones," which Letters Patent are numbered 246,512, and bear date the thirtieth day of August, in the year one thousand eight hundred and eighty-one;

And whereas by assignment, bearing date the thirty-first day of August, one thousand eight hundred and eighty-one, and duly registered in the United States Patent Office on the thirty-first day of August, one thousand eight hundred and eighty-one, the said patent and all rights under the same became vested in me, George Lee Anders, of 31 Queen Victoria Street, in the city of London, England;

And whereas the American Bell Telephone Company, a corporation created under the laws of the Commonwealth of Massachusetts, in the United States of America, is desirous of acquiring the entire interest in the said Letters Patent;

Now, therefore, to all whom it may concern: Be it known that for and in consideration of one dollar to me in hand paid, the receipt of which is hereby acknowledged, I, the said George Lee Anders, have sold, assigned and transferred, and by these presents do sell, assign and transfer unto the said American Bell Telephone Company, the whole right, title and interest, in and to the said improvements in and appertaining to transmitters for telephones, and in and to the Letters Patent therefor aforesaid; the same to be held and enjoyed by the said American Bell Telephone Company for their own use and behoof, and for the use and behoof of their legal representatives to the full end of the term for which said Letters Patent are or may be granted, as fully and entirely as the same would have been held and enjoyed by me had this assignment and sale not been made.

In testimony whereof, I have hereunto set my hand and affixed

my seal at London, in the County of Middlesex, England, this thirty-first day of August, in the year of our Lord, one thousand eight hundred and eighty-one.

[SEAL] GEORGE LEE ANDERS.

Signed and sealed in the presence of

D. E. LANGHAM, *Solicitor*,

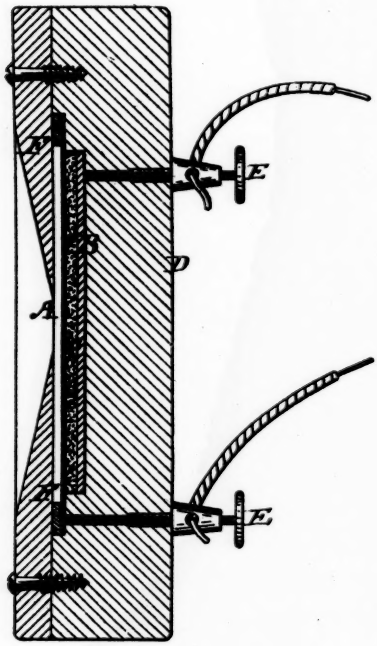
47 Lincolns Inn Fields, W. C.

(No Model.)

H. HUNNINGS.

TELEPHONE TRANSMITTER.

No. 250,250. Patented Nov. 29, 1881.



Witnesses:

E. E. Masson

Philip [illegible]

Inventor:

Henry Hunnings

by A. Pollok

his attorney

UNITED STATES PATENT OFFICE.

HENRY HUNNINGS, OF ROTHWELL, COUNTY OF YORK, ENGLAND.

TELEPHONE-TRANSMITTER.

SPECIFICATION forming part of Letters Patent No. 250,250, dated November 29, 1881.

Application filed September 30, 1881. (No model.) Patented in England September 16, 1878.

To all whom it may concern:

Be it known that I, HENRY HUNNINGS, of Rothwell, in the county of York, England, have invented a new and useful Improvement in Telephone-Transmitters, which improvement is fully set forth in the following specification.

The invention relates to telephones which are used in connection with a battery or other suitable source of electricity, and operate to throw the electric current into undulations corresponding to the sound-waves representing articulate speech or other sounds by varying the resistance of the battery-circuit, these instruments being comprised under the name of "telephone-transmitters" or "variable-resistance telephones."

The present invention has reference to the tension-regulator or variable-resistance medium in said telephones.

In the transmitters heretofore commonly used the tension-regulator consists of two or more solid electrodes, of metal or of carbon, with their surfaces in contact, or a button of compressed and consolidated material, such as lamp-black, the variations in resistance being effected by the variations in pressure between the electrodes or upon the conducting-button. Fibrous material coated with conducting particles of carbon has also been used.

In the present invention particles of conducting material in a loose and free state are used, the same being included in the electric circuit and combined with a vibratory plate or diaphragm for receiving the sound-waves, and for producing by its vibrations the variations in resistance of said particles. The loose particles of conducting matter are found to be most delicately sensitive to sonorous vibrations, and they possess the further advantage that they form a tension-regulator of low resistance, and that the transmitters containing the same can be made very compact, can be freely handled without liability of being injured, and do not require to be delicately adjusted for successful operation.

The accompanying drawing, which forms a part of this specification, shows in section a transmitter embodying the invention.

A is a vibrating diaphragm, made very thin, preferably of platinum-foil, though thin ferrotype-iron, silver, or other conducting material may be used, being fixed, as shown, or in other suitable manner, so as to be capable of vibrating freely. It is kept in place in the case D by a ring, F.

B is the back plate, of brass or other suitable metal, the intervening space being filled with loose finely-divided conducting material C. The most advantageous results proceed from the use of carbon, and particularly of oven-made engine-coke crushed very finely, not ground, so as to pulverize (not shear or tear) the particles. Metallized carbon-powder prepared with mercury or other suitable metal may, however, be used, if desired.

E E are the binding-screws, placed in connection with diaphragm A and back plate, B.

The instrument is placed in circuit with a voltaic battery and receiving-telephone of suitable construction—such as Bell's—and the words or other sounds, made close or otherwise to the instrument, will be distinctly and loudly reproduced at the receiving-instrument.

The diaphragm A, back plate, B, and case D may be altered in form, and made oval, square, or of other suitable shape, if desired; but the best results are produced if the instrument be made circular.

When the instrument is held in the hand at a convenient angle for speaking into it—say inclined from the vertical about twenty-five degrees—the weight of the particles generally packs them sufficiently, even if the chamber be not absolutely full, but has a pinch of the material taken out after filling. The handling to which the instrument will be subjected if used as a hand instrument will ordinarily keep the filling in good condition; or if by accident it becomes too tightly wedged, turning it upside down or striking it with the palm of the hand will generally restore it to the proper state.

It is obvious that the details of construction may be indefinitely varied without departing from the spirit of the invention.

Other suitable conducting material can be used in place of carbon.

The diaphragm can be made of metal-covered material, instead of wholly of metal; or a vibrating strip or plate can be attached thereto.

Having now fully described my said inven-

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tion and the manner of carrying the same into effect, I would observe, in conclusion, that no claim is made herein to carbon specifically, in contradistinction to other conducting material, as this is claimed in Letters Patent No. 246,512, granted to me August 30, 1881; but

What I do claim herein is, broadly—

1. As a tension-regulator or means for varying the resistance in a telephonic transmitter, finely-divided conducting material in a loose and free state, substantially as described.

2. The combination, with a body of finely-divided conducting material in a loose and free state, of a vibratory plate or diaphragm for varying the resistance of said body, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

HENRY HUNNINGS.

Witnesses:

JOHN TENNANT,
Solicitor, Leeds and Rothwell.

MAUDE BARRET,
Solicitor, Leeds.

HENRY HUNNINGS TO GEORGE L. ANDERS. HUNNINGS' PATENT, NO. 250,250.

Whereas I, Henry Hunnings, of Rothwell Leeds, in the county of York, England, have obtained Letters Patent of the United States for an improvement in Telephone Transmitters, which Letters Patent are numbered 250,250 and dated Nov. 29, 1881; and

Whereas, George Lee Anders, of London, England, desires to acquire the entire right, title and interest in said Letters Patent and the invention therein described;

Now, therefore, know all men by these presents, that I, the said Henry Hunnings, in consideration of one dollar to me paid by said Anders, the receipt whereof is hereby acknowledged, have assigned, sold and transferred, and do hereby assign, sell and transfer unto said George Lee Anders the said Letters Patent, the invention therein described or intended to be described, and all the exclusive rights and privileges thereby secured or intended to be secured, together with any and all reissues, renewals and extensions thereof that may be granted.

To have and to hold the same to the said George Lee Anders, his heirs and assigns, to the full end of the term or terms for which said Letters Patents or any reissues, renewals or extensions thereof are or may be granted.

Witness my hand and seal this twenty-ninth day of December, A. D., 1881.

HENRY HUNNINGS.

In presence of

DOUGLAS J. NEWTON, *Not. Pub.*,
31 Lombard Street, London, E. C.

GEORGE L. ANDERS TO AMERICAN BELL TELEPHONE CO., HUNNINGS PATENT NO. 250,250.

Whereas, Henry Hunnings, of Rothwell Leeds, in the county of York, England, did obtain Letters Patent of the United States for an improvement in telephone transmitters, which Letters Patent are

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numbered 250,250, and dated Nov. 29, 1881, and which have been assigned to me, George Lee Anders, of London, England, by an assignment of even date herewith; and

Whereas, the American Bell Telephone Company, a corporation created under the laws of the Commonwealth of Massachusetts, and having a place of business in Boston, in said Commonwealth, desires to acquire the entire interest in said Letters Patent, and the invention therein described;

Now, therefore, know all men by these presents that I, the said George Lee Anders, in consideration of one dollar to me paid by said corporation, the receipt whereof is hereby acknowledged, have sold, assigned and transferred, and do hereby sell, assign and transfer unto said The American Bell Telephone Company, the said Letters Patent, the invention therein described, or intended to be described, and all the exclusive rights and privileges thereby secured or intended to be secured, together with all reissues, renewals and extensions thereof that may be granted.

To have and to hold the same to the said The American Bell Telephone Company, their successors and assigns, to the full end of the term or terms for which said Letters Patent or any reissues, renewals or extensions thereof are or may be granted.

Witness my hand and seal, this twenty-ninth day of December, A. D. 1881.

GEORGE LEE ANDERS.

In presence of
DOUGLAS J. NEWTON,
Not. Pub.
31 Lombard Street, London, E. C.

(x)

POST OFFICE DECISIONS ABOUT J. M. BOYLE.

[Copy.]

SUBJECT: QUESTION AND REPORT CONCERNING LEGITIMACY OF AMERICAN NEWS EXCHANGE.

Office of Post Office Inspector,
Cincinnati, Ohio, Dec. 18, 1882.

Sir, — I herewith return the papers concerning an association claiming to do business in Cincinnati, Ohio, under the name and title of "American News Exchange"; and after making a personal investigation of the case, as directed, I have the honor to submit the following report, with my recommendation in the premises: —

I visited Cincinnati, and had a personal interview with the gentlemen who claim to be the firm transacting business under the title above given, visited their office, and consulted with them, and citizens of Cincinnati, Ohio, regarding their business, the standing and character of the members of the firm, their methods of conducting business in this and also in previous associations with which the partners in the so-called "American News Exchange" have been connected.

The purpose of this association, as represented in personal statements made to the Hon. Channing Richards, United States District Attorney, and myself by the members comprising said firm, is a copartnership consisting of four members, viz., W. S. Cappeller, as President, Guy Webber, J. M. Boyle and M. McCarthy; and also set forth by their prospectus and circulars, being forwarded through the mails to all parts of the country, are as follows, and are as set forth in circulars numbered 1 and 2, the collection of news from all parts of the country, through regularly commissioned correspondents, and its sale to the newspaper interests of the country. They also set forth the amount required for a fee for membership from each subscriber, agent or correspondent; also the equipment promised to each correspondent, and the amount of compensation which correspondents are to receive for news furnished. Circular No. 2, which is a fine literary production, well calculated to meet the pur-

poses of its issue, represents that its correspondents or agents already number several thousand; it also asserts as a fact that at the date of its issue the "News Exchange" were prepared to furnish any class of news matter.

It is also noticeable that all their printed matter is *without date*, which fact allows them the endless future to fulfil the pledges therein made. Circular No. 5 is on its face, instruction and information to correspondents already commissioned by the "Exchange." It refers to the opposition of monopoly, meaning as explained to me the "Associated Press." By it, circular No. 5, their correspondents and agents are informed that contracts and arrangements are being made with the publishers of the country for the disposition of their news; and by it the correspondents or agents are instructed to make no effort in furnishing the agency news until they receive notification from the exchange, such a notification being promised them within the next *few weeks*. Circulars Nos. 3, 4 and 5 set forth such inducements to agents as that they are to receive what such agents are led to expect, as passes to all public places of amusement, and on all railroad lines to all places where the business of said exchange may call them, together with the entire amount received by the exchange for news furnished by said correspondent, less ten per cent. Throughout the whole, the idea is held out that actual employment in the collection of news and information will be given them, Circular No. 6, headed "Application for Membership," presents two new features in the scheme: 1st, the additional inducement to the correspondent of a fixed compensation of three dollars and fifty cents per day for time employed; 2d, increased fee for membership, viz., ten dollars. Circular No. 7 is substantially a duplicate of No. 6, varying only in price for membership, three dollars only being required. Circular No. 8 is an authorization furnished by the Exchange to each correspondent paying either three dollars or ten dollars, not differing in either case, and by its terms the holder thereof secures the same advantages as are guaranteed to other correspondents holding certificates identical with this, and makes no attempt to recite what those advantages are. No. 8 is a printed form of letter used by the Exchange in their correspondence with an applicant for membership,

which is well calculated to perfect a business relation which the gentlemen of the News Exchange claim will prove to be mutually advantageous to both parties.

Your attention is particularly invited to the letters herewith enclosed and numbered from 10 to 14 inclusive, constituting the correspondence between the American News Exchange, J. H. Upton, of Neponset, Ill., and E. O. E. Shelby, of Cincinnati, Ohio, wherein the statement is made and impression conveyed in the communication written by the News Exchange, that their president is city auditor of Cincinnati. There is no city auditor in the municipal government of Cincinnati, O., the official title having been some time since changed to that of city comptroller, that office now being held by said E. O. E. Shelby, whom I may add, has not even a *working* interest in the American News Exchange. And in the same connection, letter No. 9 of the News Exchange to John J. Mumm, of Templeton, Iowa, wherein the same declaration is made, and also to letters Nos. 15, 16, 17, 18 and 19, three of which are addressed to the chief of police, Cincinnati, Ohio. Letter No. 20 is the form adopted by the police department, and mailed in reply to numerous inquiries received by that department in regard to the reliability of the American News Exchange. This form is not as frank and well defined in its character as were the replies of the chief officers of that Department made to my inquiries, it being prudently worded, but designed to convey the same impression as that furnished by the postmaster at Cincinnati, Ohio, in reply to similar inquiries, which are sent herewith, numbered 21.

Considered as a whole, the prospectus, circulars and other printing circulated through the mails by the News Exchange, promises very little of real value in return for the three dollars or ten dollars received from correspondents, nor do they indicate any particular time when the extremely vague and uncertain benefits promised to correspondents, are to be realized. I had, in company with the Hon. Channing Richards, U. S. Dist. Att'y, an interview with W. S. Cappeller, who claimed that he is president of the so-called "American News Exchange," of Cincinnati, and who claimed in a lengthy statement, to give us the exact status of the business of the

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association; also what it had done, and what it proposed to do: first, that it is one of three similar institutions already organized, stating positively that the Cincinnati institution was the parent institution, while the Chicago and St. Louis institutions were offshoots of the same; the Chicago branch being already in active operation, while the St. Louis branch would probably be in operation within a short time, likely within one week, and that they were one and the same institution. He informed us that negotiations had been opened with certain express and telegraph companies with a view to arranging with them for the transmission of news; also that a contract had been entered into with one Smith, of Chicago, Ill., who is a patentee of a certain kind of holder, which he claimed was useful in firmly holding stereotyped plates to a block or base, and that $500 had been paid on such contract; also stating that said Smith was interested in the Chicago branch of the exchange, this existence of a contract being the only substantial evidence recited or furnished me of the good faith of the projectors of the enterprise. Mr. Capeller admits to us that no arrangement or contract has been perfected with any newspaper or publisher furnishing a market for news which the exchange may receive. He also admits that of the 1,100 correspondents from whom the exchange has collected either three or ten dollars as membership fee, that not one has yet received anything of value or compensation for money sent, except passports, sample copies of which are enclosed herewith, numbered three and four.

In answer to my question why the preparations for active business by the purchase of machinery, and by contracts for the disposition of news, had not kept pace with the appointment and commissioning of correspondents, his reply was that the legitimacy of the enterprise had been publicly called in question by those who should have been its friends, viz., the "Associated," as well as the "Independent," press of the country; at the same time reciting the chilling influence experienced by the exchange, resulting from the holding of their remittances by the Post Office Department for ten days, which insured, as I find on investigation, delays in the receipt of about four hundred dollars. At a subsequent time, the United States district

attorney and myself met Messrs. Cappeller, Webber and Boyle, of the Exchange, at their office. At that interview, the only information obtained differing materially from that already received from Mr. Cappeller was given in a statement given by Mr. Guy Webber, who informed us that the Chicago agency had an existence, and was actually engaged in business, *prior* to the existence of the Cincinnati agency, and that they sustained no business relation with the Chicago concern until the twenty-sixth day of November, on which date the Cincinnati Exchange contracted with Smith for the use of his patent holder, and the proposed use of it by the Cincinnati Exchange being the only thing in common between the two institutions; this statement being entirely at variance with the one previously made by Cappeller.

The additional information elicited that the number of correspondents from whom membership fees had been collected, and to whom commissions had been furnished, was about eleven hundred. This corresponds with the showing on a book in which an account is kept of the receipts and expenditures of the News Exchange. While at the office on that occasion, and at a subsequent visit with Inspector Herrick, an opportunity was afforded the members of the firm to display the books of the institution, and the books presented and shown us were found to be books containing the names of thousands of people in all parts of the country, the same being arranged by States in alphabetical order, and an explanation given that these were lists of persons that the News Exchange was in correspondence with regarding membership to the concern; also a small book was shown, and which was explained by J. M. Boyle, Secretary and Treasurer of the News Exchange, to be a private account kept by him, and commenced about Oct. 1, 1882, this book purporting to be an account of the receipts and expenditures of the association. The large outlay which was made on Nov. 26, as was claimed, — that is, $500 paid to Smith in Chicago, — did not appear to have been made, as this book was represented as embracing all expenditures on account of the Exchange. The result of this inconsistency impaired my confidence, and impeaches either their system of bookkeeping, or the statements of the firm regarding the outlay of the

$500 referred to. On inquiry of Mr. Boyle, he stated to us that there were no other books kept by the concern, explaining that different firms had different ideas of the matter of bookkeeping, and that this firm did not think it necessary to have their books kept in or by an elaborate system, as frequent settlements were made between the partners; and further, that no account was kept showing the capital invested by the members of the firm, their indebtedness, or the terms of copartnership.

While at the office and headquarters of the News Exchange, my observations concerning the surroundings and the facilities prepared in and with which the proposed business of the News Exchange is being conducted, was the lack of accommodation for the transaction of a business of such a gigantic nature as is described and set forth in their circulars and other printed matter. The business is now being transacted in two small rooms, in one of which are desks and tables occupied by girls who are engaged in preparing circulars and correspondence for the mails, there being no machinery, and the entire property, furniture and equipments amounting to less than one half a wagon load. During my second visit to the office I observed that the occupants were not in direct or immediate telegraphic communication with the outside world, nor did I encounter a single one of the numerous newspaper and literary men of the country, and I noticed an entire absence of the editorial force and corps referred to in the advertising of the Exchange.

In considering the facts heretofore mentioned in this report, and in connection with them, as a manner of determining the character and reliability of the exchange, I deem it proper to refer to the business reputation and antecedents of the persons comprising the firm.

In reply to numerous inquiries among the citizens of Cincinnati, I find that those having a general or passing acquaintance with W. S. Cappeller remarked that they are surprised at his connection with such a concern, and his association with such men as Webber and Boyle; while those who are more intimately acquainted with him and his methods of obtaining money, referring especially to his connections with Boyle and Webber in a scheme for obtaining money, and known as the "Prentis Preserving Company," the pre-

servative advantage being known or called "ozone," the system of doing business or obtaining money by this concern being almost identical with that of the American News Exchange; such persons remark that they are not surprised by a knowledge of his connection with the firm whose business is the subject of this investigation.

Guy Webber: The matter of this gentleman's reputation in Cincinnati among the respectable business men is only known through the fact of his known connection with the American Art Exchange, Great Western Jewelry Company, National Art Company, Union Silver Plating Company and the Prentis Preserving Company, these different concerns all gotten up with the evident purpose of obtaining money without giving any substantial equivalent in return, and resulting in the accomplishment of that purpose only. With reference to the different institutions named above only one opinion is expressed or can be obtained, and that being that they are unmitigated frauds both in purpose and intent as well as in result, a portion of these concerns having been denied the use of the mail on account of the fraudulent character of the enterprise. My opinion, which is based upon the facts stated and inquiries made, as well as my own observation regarding the man, is that he lacks the business integrity which would be becoming to one of the proprietors of a business institution entitled to the confidence of the people. In this opinion I am supported by the general sentiment of the respectable persons having any knowledge of him; in fact, he is indirectly commended to me as being the sharpest confidence man in Cincinnati.

With reference to J. M. Boyle, who, as he appears in Cincinnati with reference to acquaintance and reputation, is a star of less magnitude, being only known through his connection with the present scheme, and as being the person who introduced or formulated the "twin scheme," known as the "Prentis Preserving Company," he being entirely without any desirable reputation.

M. McCarthy, who signs himself as manager, I entirely failed to meet. Of his existence I am almost in doubt, as a portion of the gentlemen named informed me that they comprised the entire firm; while Mr. Boyle informed me that McCarthy is a veritable reality, having a working interest in the exchange which entitles him to a

share of the profits. After a careful examination of all printed matter circulated through the mails, and the advertisements in the newspapers, I find that very little of positive value is offered to subscribers or correspondents, although the delusive hope or expectation is created and encouraged that much profit is to result in return for the fees charged. I find that these consist in the fact that the passports advertised are supposed to be passes or free tickets which will admits holders to public places of amusement, while in fact, they are certificates of membership requesting courtesies of managers of such public places of amusement, signed by the "American News Exchange," which concern is without influence with managers of such amusement enterprises. The same facts apply to what is termed as transporation passports, they being for your convenience, numbered three and four, both being entirely valueless for the purpose set forth by the exchange in their correspondence with agents.

The inducement is held out that monied compensation will be paid correspondents for news and information by them collected and furnished the Exchange, the terms promised being that such correspondents shall receive the entire sum received for the same by the Exchange, less ten per cent. They also set forth that they have a market for such news and information, which is not true by their own confession made to me. It will be seen that they only pledge a sum equal to the amount received; and as they receive nothing there is no failure to comply with the promise made. While in one circular (No. 2) they announce to publishers their readiness to furnish news of all kinds, they also, in another, numbered 5, inform correspondents that they are not prepared to receive news, but will notify them when in readiness to receive such news and information, no time being fixed, the probable date being some time in the remote future.

After careful attention and reflection regarding personal statements and explanations by the president of the "American News Exchange," and Messrs. Webber and Boyle, regarding the business of the Exchange, its purposes, etc., and fair consideration of all evidence furnished me by them and otherwise obtained, I am not favorably

impressed regarding the reliability of its members or the responsibility of the enterprise known as the American News Exchange. It lacks all the solid business features that pertain to a substantial business enterprise, and also lacks facilities for the transaction of the business proposed. The contradictory statements made by the several members of the firm regarding important facts, indicate to me that as individuals they lack that integrity which is essential to inspire that confidence which is so generally wanting throughout the country regarding this concern.

I find in answer to their newspaper advertisements and circulars sent through the mail by money order and registered letter in sums varying from $2 to $10, commencing about the 15th of October, amounting in all to date to about $3,500. This has and is being done, as I believe, in violation of the spirit of the United States law, as found in Section 5,480, Revised Statutes; that while this is true, the scheme is so ingeniously drawn, and the facility with which witnesses can be corrupted, and their testimony made useful only to the defence by simply giving them an order for work and pay for the same, compels me to the conclusion that they cannot be successfully prosecuted, although their business is, in my opinion, clearly fraudulent in its character, and as such its business and interests should not be promoted by the facilities offered by the use of the United States mail.

Regarding the prudence of prosecuting the members constituting the News Exchange, I am sustained by the written opinion of Hon. Channing Richards, United States District Attorney, which I enclose herewith, he being thoroughly conversant with all the features of the case, having devoted much time with me in its investigation. In this written opinion furnished me, he advises against prosecution, while he does not disagree with me regarding the character of the exchange. The situation is such that I realize that the United States Statutes furnish no adequate protection to fools.

I believe the American News Exchange of Cincinnati, Ohio, to be a fraud, and, as it appears, deals only "in futures," and as such, recommend that it be denied the use of the United States mails for the transaction of its business, feeling morally certain that should the

Department adopt my recommendation in the case, and that by the enforcement of such a order, there will pass out of existence one of the most stupendous and finely gotten up schemes to defraud ever perfected.

Very respectfully,

(Signed) J. H. BROWN,
Inspector.

REPORT OF A. A. FREEMAN, ASST. ATTY-GENERAL.

[COPY.]

OFFICE OF ASSISTANT ATTORNEY GENERAL
FOR THE POST OFFICE DEPARTMENT,
WASHINGTON, D. C., Jan. 15, 1883.

SIR, — The American News Exchange is a concern that professes to do business at 251 and 253 West Fifth Street, Cincinnati, Ohio.

The declared purpose of the concern is to gather news from all portions of the country, and to sell the same to such journals as may see proper to avail themselves of its facilities.

In order to accomplish that purpose, it proposes to employ agents in every portion of the country. "The system which our Exchange contemplates will leave unwatched no nook or corner from Maine to California, from the Gulf to Manitoba; in each and every neighborhood will our correspondents be on the watch, alert and vigilant, and with the incentive which good pay for good work will furnish."

[*See circular entitled*, "*American News Exchange*," *marked Exhibit* , *marked lines.*]

It proposes to pay "liberally" for such news as its correspondents may furnish. It declares that these correspondents are to be drawn from every occupation in life, etc.; that the work to be performed will not interfere with any other occupation; that the farmer, merchant, or school-teacher may profitably enter the field, etc.

The plan by which it proposes to utilize the labors of its correspondents is also set out in its circulars, and consists in a process of electrotyping news, and distributing the same, by means of express companies, from its central office to such interior papers as may become its patrons.

It proposes to charge its agents or correspondents a membership fee of ten dollars ($10), five to be paid on becoming an agent, and five dollars to be retained out of the proceeds of the first amount to become due the agent on account of work done for the concern. The proposition it makes is to furnish the agent with a letter of appointment, and also an amusement and a traveling card. The former is a card addressed to managers of houses of amusement, stating that the bearer is a member of the "Exchange," and asking that the usual courtesies afforded to correspondents of newspapers be extended to him. The latter is a similar card directed to managers of railroads.

The correspondent is also promised a stated sum for all such item of news furnished by him as the concern may use, twenty-five cents per inch for each one hundred papers in which the same may be published.

The concern claims to have perfected arrangements with a large number of newspapers for the use of its facilities, and claims also to have in its employ about ten or eleven hundred correspondents.

The scheme has been extensively advertised. As a result, numerous letters of inquiry have been coming to the postmaster at, and the police authorities of Cincinnati, seeking information as to its reliability.

The attention of the Department having been called to the matter, it was referred to the Chief Inspector, and by him to Inspector Brown, who, under date of the 18th ult., made his report. His report is full, and in my opinion as explicit as the nature of the case will admit.

I omitted to state in the proper connection, that a preliminary notice was sent to the concern upon what seemed very strong evidence of fraud, but on request being made the final order was withheld pending an investigation by the Inspector.

On the first of December, 1882, W. S. Cappellar, president of the concern, filed a sworn statement denying the accusation of fraud, and setting out in detail the operations of the concern.

To undertake to set out even the substance of the large number of papers on file, would not only require more time than I have at my

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command, but would throw around the case but little additional light to that afforded by the very careful and well considered report of Inspector Brown.

I have examined with minute care, every paper filed in the case, and am compelled to state as a result of that examination that the question presented for your determination is one of some difficulty.

You must be *satisfied* that the concern is engaged in obtaining money through the mails by means of false and fraudulent pretences, representations, etc. Now the case made out is substantially this: —

The "News Exchange" sends its circulars to the public. It also advertises in newspapers stating that it wants correspondents in every nook and corner of the country. In answer to its advertisements it receives letters of inquiry as to its business, its terms, etc. It also sends its circulars not only to those who address it, but to every person whose name and address it has been able to procure. That circular makes a most plausible and enticing proposition. It offers employment that is not to interfere with other employment, traveling expenses, admission to theatres, passes on railroads, $3.50 per day, besides a liberal compensation for news furnished. True, there is no positive undertaking that the correspondent will be called upon to travel, nor is he assured that the matter he sends for publication will be used.

I say these conditions are not positively promised, but every possible inducement is held out to make him *believe* that such will be the case. For he is told that prior experience as a newspaper correspondent is not necessary, as the concern has a corps of experienced newspaper men to revise all matter sent.

Probably a more enticing proposition could not be devised, for aside from the consideration of profit, how many men are there who would hesitate to pay the paltry sum of $3.50 or $5.00 for a free ticket to all the shows and theatres and over all the railroads of the country? To say nothing of having their communications printed in from one hundred to one thousand papers, at from twenty-five (25) cents to $2.50 an inch, according to the number of papers using it. To any considerate mind, this scheme presents an ex-

tremely suspicious appearance, as is evidenced by the numerous letters of inquiry already alluded to.

Before you reach your conclusion, however, I would advise you to give Mr. Cappellar's affidavit (a copy of which is enclosed a careful examination. It will be found on examination of this affidavit that the substance of Mr. Cappellar's defence is that he and his company are honestly trying to do what they proposed to do in their advertisement; that they have been embarrassed by opposition from the Associated Press and from the Independent Press, and also by the action of this department; that they have expended much money in perfecting their scheme, and have contracted for still greater expenditures; that they are perfecting their arrangements as fast as possible, and hope in a short time to be able to do all that they have proposed to do.

Referring to the matter of fees required of correspondents, he explains that this is to cover expenses, — stating that these fees do not pay "*one half* our current expenses."

Referring to card to railroad managers, he says that "these cards are not 'passes'; they are simply credentials and requests that the usual courtesies be extended to our correspondents, etc."

He says: "The enclosed slip," Exhibit B, "will indicate in what appreciation our system of furnishing both news and miscellaneous plate matter is held."

He proceeds to say that, "within a year we shall certainly be supplying one half of the daily papers with our news plates."

You will observe on reading this affidavit: —

1st. That the affiant practically brands his own statements, as set out in his circulars, as false and fraudulent in this, viz.: The whole tones and tenor of its advertisements is to the effect that the organization has a *present active existence*. Look at its advertisements in the papers herewith filed, marked "C" and "D," or any of its circulars, and they all speak, not of what the concern proposes to do, but what it *is* doing.

The affiant in his affidavit, however, speaks entirely of what the concern *expects* to do. In view of the statements made in these papers, especially in the newspaper advertisements, and in further

view of the fact that over three thousand dollars have been collected from about eleven hundred agents, it is astounding to know that *not a plate has been made, not an item of news furnished, and not one cent paid to a correspondent.* And yet I understand this to be the true state of the case. The inspector states that the parties concerned admitted that they had perfected no arrangement with any newspaper, and had paid none of their correspondents.

[*See inspector's report, p. 5.*]

In view of this fact, I call your special attention to the following quotations; the first from the newspaper advertisement, which is as follows: —

"The American News Exchange has a very complete system of collecting the important news of the day through its correspondents, and, in addition to furnishing the news by letter or telegram, has begun the operation of a new feature in journalism. We will prepare each morning, in time for the early trains, six columns of *telegraphic news plates.* . . . . These plates are shipped each morning on the early trains, which enables our customers (who have their forms otherwise ready for press) to insert the plates, and have copies of their paper on the street within a few minutes after arrival of the train; and the telegraph news will invariably be found as complete in detail, and as thorough in representing the world's news, as that furnished by any metropolitan paper."

The second is from their circular, and is as follows: —

"It will be necessary, if you desire the membership, to apply at once, as the vacancies are being rapidly filled, and, in the interest of all concerned, we cannot delay in making appointments."

These statements are both false and fraudulent. The first is false absolutely, in that it states that which is totally untrue. The second is false in effect, in that the interest of all concerned did *not* forbid delay in making appointments. On the contrary, in the very nature of a business of this character, the appointment of agents should be the *last*, instead of the first in order.

I desire to call your attention again to Mr. Cappellar's affidavit, and for that purpose I make the following quotation: "We have completed purchases and contracts for the accomplishment of the

following work: The right to use the new patent clasp or stereotype plates recently invented by R. W. Nelson of Chicago; the establishment of an office in Cincinnati, on the same plan as is now being successfully carried out by the Chicago office, viz., supplying daily papers within a radius of two hundred miles of each central office, with six columns of stereotype telegraph news plates. Matter for these plates is set up at night, the same as any morning paper would perform the work. Our forms close at six o'clock A. M. By the stereotyping process mentioned, we complete a set of six columns in seventy seconds, ready for shipment. On the same trains that carry the morning papers to interior towns are carried our plates, and within ten minutes after their receipt the home afternoon daily paper can have its issue on the streets, with full telegraphic reports.

"The Chicago office is now supplying upward of fifty papers in this manner, *four in the city of Chicago*, and in every case with perfect satisfaction. The enclosed list of papers will indicate the business already being done in this direction. By Jan. 1, 1883, an office for this same work will be established in St. Louis, and as rapidly as the necessary machinery can be procured, offices will be established in Detroit, Buffalo, Baltimore, Pittsburg, New York, Philadelphia, Boston, and such other points as the business may require.

"The aim will be to establish such offices at the proper intervals to thoroughly cover the intervening territory with day service of telegraphic news plates for interior daily papers."

From "the enclosed list" I quote the following: "Among the daily papers now using these plates are the following: . . . ". He then gives the names of fifty-five papers, and concludes as follows: "Contracts to supply other daily papers are daily being made in gratifying numbers through the distributing offices already established; and when the system is at its best, with offices in Cincinnati, Chicago, St. Louis, Detroit, Buffalo, Pittsburg, Philadelphia, New York, Boston, and such Southern and Western cities as are necessary to cover the territory, it is not anticipating too much to believe that thousands of daily and weekly newspapers will be supplied with the best news and miscellany service that it is possible to perform."

I am not warranted in saying that Mr. Cappellar intended to convey the impression in this affidavit, that his concern was in actual operation, and that the plates referred to are those furnished by the American News Exchange, but read in connection with his statement in his advertisements, that the "American News Exchange . . . has begun the operation of a new feature in journalism. . . . . These plates are shipped each morning on the early trains, which enables our customers, etc."

This affidavit is an extraordinary one if Inspector Brown's statement that "Mr. Cappellar admits to us that no arrangement or contract has been perfected with any newspaper or publisher furnishing a market for news which the Exchange may receive," etc., be true.

In view of the fact, however, of Mr. Cappellar's good character, and in further view of the fact that he charges that this proceeding against him grows out of hostility entertained towards him by "Associated Press," and that Inspector Brown was improperly influenced by this prejudice, I have the honor to suggest that this case be recommitted to the Chief Inspector, with direction to that officer to make a personal investigation of the charges of fraud alleged against this concern.

So far as I am concerned, however, I am satisfied that the Mutual Press Association and American News Exchange of Nos. 251 and 253 West Fifth Street, Cincinnati, Ohio, are engaged in a scheme to obtain money through the mails by means of false and fraudulent pretences, representations and promises, and therefore advise that you issue an order directing the Post Master at Cincinnati, Ohio, to refuse payment of money orders, and the delivery of registered letters to said concern.

Very respectfully,

(Signed) A. A. FREEMAN,
Ass't Att'y Gen.
Post Office Dept.

Hon. T. O. Howe,
Postmaster General.

DECISION OF POSTMASTER GENERAL

[COPY.]

POST-OFFICE DEPARTMENT,
WASHINGTON, D. C., Jan. 20, 1883.

Order No. 479.

It having been made to appear at this department that the "American News Exchange," at 251 and 253 West Fifth Street, Cincinnati, Ohio, is engaged in conducting a scheme or device for obtaining money through the mails by means of false and fraudulent pretences, representations and promises, and the said party having failed, after due notice, to show cause to the contrary.

I do therefore forbid the payment by the postmaster at Cincinnati, Ohio, of any postal money order drawn to the order of said "American News Exchange," and the said postmaster is hereby directed to inform the remitter of said postal money order that payment thereof has been forbidden, and that the sum of said money order will be returned upon presentation of a duplicate money order applied for and obtained under the regulations of the department.

And upon the same evidence the postmaster at Cincinnati, Ohio, aforesaid, is hereby instructed to return all registered letters which shall arrive at his office directed to the said "American News Exchange" to the postmasters at the offices at which they were originally mailed with the word "fraudulent" plainly written or stamped upon the outside of such letters.

(Signed) T. O. HOWE,
Postmaster General.

To postmaster, Cincinnati, Ohio.

pt.

CIRCUIT COURT OF THE UNITED STATES,

SOUTHERN DISTRICT OF NEW YORK.

IN EQUITY.

AMERICAN BELL TELEPHONE COMPANY ET AL.

v.

ASHAEL K. EATON ET AL.

BILL OF COMPLAINT.

To the Honorable the Justices of the Circuit Court of the United States for the Southern District of New York:

The American Bell Telephone Company, a corporation duly established under the laws of the Commonwealth of Massachusetts, and the Metropolitan Telephone and Telegraph Company, a corporation duly established under the laws of the State of New York, bring this their bill of complaint against Ashael K. Eaton, Cornelius T Tompkins, The Eaton Telephone Company, a corporation organized under the laws of the State of New York, and the Union White Lead Manufacturing Company, a corporation organized under the laws of the State of New York. And thereupon your orators complain and say, that before the seventh day of March, 1876, Alexander Graham Bell, then of Salem, now of Boston, in said Commonwealth, being the original and first inventor of a new and useful improvement in telegraphy, which was never known or used before his invention thereof, and which had not at the time of his application been in public use or on sale for more than two years, made application according to law for Letters Patent of the United States to be granted to him therefor; upon which application, due proceedings being had in all respects, said Letters Patent were on the seventh day of March, 1876, granted, issued and delivered to said Alexander Graham Bell, signed by the Secretary of the Interior and countersigned by the Commissioner of Patents, and numbered 174,465, whereby there was secured to said Alexander Graham Bell, his heirs, administrators or assigns, for the term of seventeen years from the said seventh day of March, 1876, the full and exclusive right and liberty of making, constructing, using and vending to

others to be used the said improvement, a description whereof is given in the words of the said Bell, in the schedule annexed to said patent, and forming a part thereof, as by said patent, numbered 174,465, or a copy thereof here in court to be produced, will fully appear.

That before the thirtieth day of January, 1877, the said Alexander Graham Bell, being the original and first inventor of another new and useful improvement in electric telegraphy, which was never known or used before his invention thereof, and which had not at the time of his application been in public use or on sale for more than two years, made application according to law for Letters Patent of the United States to be granted to him therefor; upon which application, due proceedings being had in all respects, said Letters Patent were, on said thirtieth day of January, 1877, granted, issued and delivered unto said Bell, signed by the Secretary of the Interior and countersigned by the Commissioner of Patents, and numbered 186,787, whereby there was secured to said Bell, his heirs, administrators or assigns, for the term of seventeen years from the said thirtieth day of January, 1877, the full and exclusive right and liberty of making, constructing, using and vending to others to be used, the said improvement, the description whereof is given in the words of said Bell in the schedule annexed to said last-named patent, and forming a part thereof, as by said patent, numbered 186,787, or a copy thereof, here in court to be produced, will fully appear.

That said Alexander Graham Bell assigned said Letters Patent, numbered respectively 174,465 and 186,787, to Gardiner G. Hubbard, trustee, by deed of assignment dated July 9, 1877, and recorded at the Patent Office July 28, 1877, Liber R. 21, page 399 of Transfers of Patents. That said Gardiner G. Hubbard, trustee, assigned said Letters Patent, numbered respectively 174,465 and 186,787, to the Bell Telephone Company, by assignment dated July 20, 1878, and recorded at the Patent Office, Oct. 3, 1878, Liber Y. 22, page 460 of Transfers of Patents.

That said Bell Telephone Company has granted the same to your orator, the American Bell Telephone Company, by an instrument in

writing, dated June 21, 1880, and recorded at the Patent Office, June , 1880, Liber page of Transfers of Patents.

That by license under said American Bell Telephone Company, the Metropolitan Telephone and Telegraph Company, a corporation organized under the laws of the State of New York, has acquired the sole and exclusive right to use and to license others to use telephones within a territory which includes all of the States of New York and New Jersey within thirty-three miles of New York City Hall, and all of Monmouth County, New Jersey, and all of Long Island, and is now engaged in the business of supplying electric speaking telephones and erecting telephone lines in said territory; which telephones it receives from said American Bell Telephone Company, and for the use of which it pays a yearly license fee and royalty to said American Bell Telephone Company, and receives a yearly royalty and license fee from its sub-licensees; and but for the unlawful acts of the defendants and their associates, hereinafter complained of, would be in the full and exclusive enjoyment of said right.

Your orators further show, that after the grant of said Letters Patent, the inventions therein described and claimed, or substantial and material parts of the same, embodied in instruments known as Bell telephones, and in instruments known as Blake transmitters, were introduced into public use by the said Bell, the said Hubbard, trustee, the said Bell Telephone Company and your orators. That many thousands of persons have put the said inventions into daily use under the authority and license of the said Hubbard and your orators and their predecessors and those holding rights or licenses under them, and have paid for such use of said inventions the amount fixed by the owners of said patents as a reasonable compensation therefor, such payments amounting in the aggregate to many thousands of dollars. That the fact that said Bell was the original and first inventor of said inventions, and that the patents above named are good and valid patents, has been generally recognized and acknowledged by those who have used the inventions and the public generally, and the claims of the said Bell, Hubbard, and your orators and their said predecessors to the exclusive right to the said inventions under said patents have been generally acknowledged and acquiesced in. That from time to time several persons have

attempted to make, sell and use telephones, or parts thereof, embracing said inventions, but that in such cases said Hubbard while owner of, and your orators and their said predecessors since they have owned said patents, have immediately, upon hearing of such acts or attempts, notified such parties to desist therefrom, and that such parties have generally, upon receiving such notices, complied therewith, and acquiesced in and recognized as valid the claims of said Hubbard and your orators under said patents; and said Bell, said Hubbard and your orators have always asserted and maintained, and but for the wrongful acts of the defendants would and have hitherto almost universally enjoyed the sole and exclusive right to practise said inventions; that they have not acquiesced in any infringement of their exclusive rights; and that the said exclusive rights of your orators are of great value to them.

That in the year 1878, Addison D. Hard, of Boston, electrician, infringed said Bell patents by making and selling telephones, or by making and selling the material and substantial parts thereof for the purpose of being put together and used as telephones; that thereupon the said Bell Telephone Company brought their bill in equity against him, in the Circuit Court of the United States for the District of Massachusetts; that an injunction was issued against him to desist from such infringement; and afterwards, and after hearing, the defendant was adjudged in contempt for violating said injunction, and was ordered to pay a sum of money into court, which sum was afterwards, to wit, Feb. 4, 1879, ordered to be paid, and was paid to said Bell Telephone Company.

That in the year 1878, one Jerome C. Redding also infringed said patents, and a bill in equity was brought against him in said court to restrain said infringement, and no defence was made, and an injunction issued, and said Redding desisted from further infringement.

That in the year 1878, one Jesse H. Bunnell, manufacturing electrician, did, in the city of New York, in like manner infringe said Bell patents; that thereupon the said Bell Telephone Company brought their bill in equity against him in the Circuit Court of the United States for the Southern District of New York; that he appeared thereto by counsel; that thereafter he submitted to the

claims of the plaintiff; and that on the eighth day of February, 1879, an injunction was issued against him, restraining him from further infringement of said patents, and no further proceedings have been had in said cause.

And all said orders and decrees stand in full force and effect.

That the said exclusive rights of said Bell, and your orators and their predecessors as his assigns and grantees, have never been openly or publicly violated, except at one time, and in the year 1878, by the Western Union Telegraph Company, and by the Gold and Stock Telegraph Company, and by the American Speaking Telephone Company, said three corporations having associated themselves together for that purpose; that said Bell Telephone Company brought its bill in equity in the Circuit Court of the United States for the District of Massachusetts, against Peter A. Dowd, an agent of said associated companies, engaged in the business of using their infringing telephones, and in said suit complained of the defendant that he had infringed the fifth claim of said patent 174,465; and also complained that he had infringed the third, sixth, seventh and eighth claims of said patent 186,787; the said associated corporations assumed the defence of said suit, and employed in said defence their counsel and experts learned in the law and skilled in the art: in said suit evidence was taken and completed by the complainants in chief, and by the defendant in defence, and by the complainants in reply; and thereupon, upon consideration of said proof, and the opinions of their professional advisers, the defendant and said corporations became satisfied that said Bell was the true, original and first inventor of the electic speaking telephone, and the inventions covered by said patents; whereupon they submitted to the said claims of the complainants, and agreed to desist from further infringements, and have since desisted from further infringements, and placed and caused to be placed all telephones within their power or control under license under said Bell patents, and paid, or caused to be paid, the usual and customary yearly royalties therefor habitually charged by the assigns of said Bell to other parties for like uses, and agreed that they would not thereafter make electric speaking telephones, and would not thereafter use electric speaking telephones, except such as should be

made and furnished to them by your orators or the assigns of said Bell, and under license under said Bell patents, and that for the use of the same they should pay not less than the usual and accustomed royalties from time to time charged to others by your orators.

And your orators show that the telephones made by your orators and the infringing telephones of the defendants are small instruments, and easily concealed, and easily used in private, and easily transferred from one person to another, so that it is generally extremely difficult for your orators to detect all instances of such use, and extremely difficult to prove the use thereof by persons not licensed by your orators, and the extent of such use, and would be extremely onerous and burdensome for your orators to bring separate suits against each user to restrain said infringing use; and so, if the defendants, or any of them, shall be allowed to continue to manufacture and suppy such instruments for use during the pendency of this suit, your orators will be wholly without adequate remedy in the premises.

Yet the defendants, well knowing the premises and the exclusive rights of your orators as aforesaid, but contriving to injure your orators and to deprive them of the benefit and advantage which might and otherwise would accrue to them from said inventions, without the license or consent of your orators and in infringement of the said patents, as your orators are informed and believe, have made, sold and used telephones embracing the inventions secured to your orators in said Letters Patent, or substantial and material parts of them, and have used the several improvements secured to your orators by said patents, and are still using the said several improvements at the city of New York and divers other places within said district, and have furnished electric speaking telephones made by it to a considerable number of persons within this district, to be connected up, and used as electric speaking telephones for the transmission of articulate speech, by and according to the method secured to said Bell and to your orators by said patents, and still continue so to do; but precisely how long the defendants have made, sold and used the said several improvements, and to what extent they have made, sold and used them, your orators, for want of a discovery thereof, do

not know and cannot set forth, and they pray that the defendants may be compelled to set forth the same in their answer.

And your orators have requested the said defendants to acknowledge their rights in the premises, and to desist and refrain from the said acts, and from disregarding and infringing your orators' said rights, and to account with and pay to your orators what is justly due to your orators by reason of said infringement.

But now so it is, may it please your Honors, that the defendants wholly refuse so to do; but, on the contrary, continue and threaten to continue said infringement of the rights of your orators aforesaid, and particularly the said Eaton Telephone Company, and said Eaton and said Tompkins threaten to make and put out other like instruments, and thereby cause irreparable injury to your orators' lawful business. All which is contrary to equity and good conscience.

To the end, therefore, that the said defendants may if they can show why your orators should not have the relief herein prayed, and may upon their oaths, and according to their best and utmost knowledge, remembrance, information or belief, full, true, direct and perfect answer make to all and singular the matters hereinbefore stated and charged, as fully and particularly as if the same were here repeated, and they especially interrogated as to each and every of said matters, and more especially may answer, discover and set forth, whether during any and what period of time, and whether at said New York or elsewhere, and when and where they used said improvement, or either of them; and whether they manufactured or sold any electric speaking telephones or apparatus to transmit speech by electricity, or the various parts of such telephones, and how many they have made or sold, and to whom they have sold the same, and how the said telephone and the several parts of the same are constructed and used.

And your orators show that they are entitled to restrain all further use of telephones which have been or shall be manufactured and disposed of by the defendants or either of them, and to receive and collect from each user thereof a suitable sum as and for damages and profits in consequence of and growing out of such use by each person who has used the same; and not waiving said rights, but wholly insisting thereon, and asserting that they intend to pursue and en-

force said rights against said users, your orators aver that the defendants are also liable to pay to your orators other sums as and for profits by them actually realized by and from said infringement and unlawful acts. Wherefore your orators pray that the defendants may be decreed to account for and pay over to your orators all such gains and profits resulting to them from said infringements; and may be restrained, together with their servants and agents, by an injunction to be issued out of this honorable Court, or by one of your Honors, according to the law in such case provided, from making, selling or using the said improvements, patented as aforesaid, or either of them; and that they may also be enjoined and restrained as aforesaid, during the pendency of this suit, and for such other and further relief in the premises as the nature of the case may require and to your Honors shall seem meet.

May it plea-e your Honors to grant unto your orators, not only a writ of injunction, but also a writ of *subpœna*, to be directed to the said defendants and each of them, commanding them and each of them, at a certain time and under a certain penalty, therein to be limited, personally to be and appear before your Honors and this honorable Court, then and there to answer unto this bill of complaint, and to do and receive what to your Honors shall seem meet in the premises.

THE AMERICAN BELL TELEPHONE COMPANY,
By W. H. FORBES, Prest.

THE METROPOLITAN TELEPHONE AND TELEGRAPH COMPANY,
By W. H. FORBES, Prest.

DICKERSON & DICKERSON,
Solrs and Counsel for Complts.

UNITED STATES OF AMERICA,
STATE OF MASSACHUSETTS, } ss.
ESSEX COUNTY,

JUNE 23, 1880.

Personally appeared William H. Forbes, above named, and having been duly sworn, doth depose and say, that he is president of said American Bell Telephone Company, and of said Metropolitan Telephone and Telegraph Company, and of said Bell Telephone Company; that he has read the foregoing bill and knows the contents thereof; that all the matters therein stated as to the acts of said three

corporations he knows to be true; that all other matters therein stated he believes to be true; and believes the said Bell to be the true, first and original inventor of the improvements in said two patents set forth and claimed.

Sworn to before me,

[SEAL] WILLIAM FABENS,
Notary Public.

[ENDORSED.]

UNITED STATES CIRCUIT COURT,
SOUTHERN DISTRICT OF NEW YORK.

THE AMERICAN BELL TELEPHONE COMPANY ET AL.
vs.
ASHAEL K. EATON ET AL.

BILL OF COMPLAINT.

BILL OF COMPLAINT.
DICKERSON & DICKERSON,
Solrs for Complts.

U. S. CIRCUIT COURT.
FILED JUNE 24, 1880.
JOHN I. DAVENPORT, *Clerk.*

ANSWER.

UNITED STATES CIRCUIT COURT.
SOUTHERN DISTRICT OF NEW YORK.

THE AMERICAN BELL TELEPHONE COMPANY AND THE METROPOLITAN TELEPHONE AND TELEGRAPH COMPANY, *Complainants*,
v.
ASHAEL K. EATON, CORNELIUS T. TOMPKINS, THE EATON TELEPHONE COMPANY, *impleaded with another defendant.*

The answer of the defendants, Ashael K. Eaton, Cornelius T. Tompkins and the Eaton Telephone Company, to the bill of complaint herein.

DEFENDANTS' ANSWER.

These defendants, now and at all times hereafter, saving and reserving unto themselves all and all manner of benefit and advantage of exception that can or may be taken to the many errors, uncertain-

ties and insufficiencies in the said bill of complaint contained, for answer thereto, or unto so much thereof as they are advised it is material or necessary for them to make answer unto, answering say: —

I. That they do not know and are not informed save by said bill whether or not either of said complainants is a corporation duly established as alleged in said bill, and they therefore deny the same, and leave the complainants to make such proof thereof as they may be advised.

II. And these defendants, further answering, admit that Letters Patent of the United States, numbered 174,465, were on the seventh day of March, 1876, granted to Alexander Graham Bell, for an alleged new and useful improvement in telegraphy; but whether or not said Letters Patent were duly applied for or issued as stated in said bill, these defendants do not know and are not informed save by said bill, and they therefore deny the same, and leave the complainants to make such proof thereof as they may be advised.

III. And these defendants, further answering, admit that Letters Patent of the United States, numbered 186,787, were on the thirtieth day of January, 1877, granted to said Bell for an alleged new and useful improvement in electric telegraphy; but whether or not said Letters Patent were duly applied for or issued as stated in said bill, these defendants do not know and are not informed save by said bill, and they therefore deny the same, and leave the complainants to make such proof thereof as they may be advised.

IV. And these defendants, further answering, say that they do not know and are not informed save by said bill whether either of the assignments mentioned therein was made or recorded as alleged, or whether or not the complainant, the Metropolitan Telephone and Telegraph Company, has received a license as alleged in said bill, and they therefore deny the same, and leave the complainants to make such proof thereof as they may be advised.

V. And these deponents, further answering, on information and belief aver that long before any invention by said Bell of the alleged improvement specified as his invention in said Letters Patent numbered 174,465, the same was known and used by the following persons at the following places, to wit: —

By whom used.	Residence.	Where used or known.
Elisha Gray	Highland Park, Illinois.	Oberlin and Cleveland, Ohio, Highland Park and Chicago, Ill., and New York City.
Thomas A. Edison	Menlo Park, New Jersey.	Menlo Park, N. J., and New York City.
Amos E. Dolbear.	Somerville, Massachusetts.	Somerville, Mass.
Alfred G. Holcomb.	Granby, Connecticut.	New York City, N. Y.
Philip H. Vanderweyde,	New York City, New York.	New York City, N. Y.
W. F. Channing	Providence, Rhode Island.	Providence R. I.
Benjamin F. Edmands,	Deceased.	Boston, Mass., Washington, D. C., and New York City.
James Hamblett, Jr.	Brooklyn, New York.	Boston, Mass., Washington, D. C., and New York City.
Ashael K Eaton	Brooklyn, New York.	Brooklyn N. Y.
Edward Farrar	Keene, New Hampshire.	Keene, N. H.
Antonio Meucci	Clifton, Staten Island.	Staten Island and New York City.
Charles Bourseuls	France.	France.
Phil. Reis	Friedrichsdorf, Germany.	Friedrichsdorf, Frankfort, Germany.
W. L. Voelker	Morton, Delaware Co., Pennsylvania.	Morton, Delaware Co., Pa., Chicago and other places.
John H. Irwin	Philadelphia, Pennsylvania.	Philadelphia, Penn.

And also by numerous other parties whose names and residences are now unknown to these defendants, but which, when known, these defendants pray leave by proper amendments to insert in this answer.

VI. And these defendants, furthering answering, allege on information and belief that long prior to any invention by said Bell of the alleged improvement specified as his invention in said Letters Patent numbered 174,465, the same was described in and patented by the following Letters Patent, viz.: Letters Patent granted by the United States in the year 1873, to Thomas A. Edison and George Harrington, dated Aug. 12, 1873, numbered 141,777; Letters Patent granted by the United States to William Thomson, in the year 1874, dated Nov. 17, 1874, numbered 156,897; Letters Patent granted by the government of Great Britain, in the year 1840, to Charles Wheatstone, dated Jan. 21, 1840, numbered 8,345; and also other Letters Patent which are now unknown to these defendants, but which, when known, these defendants pray leave by proper amendments to insert in this answer.

And these defendants, further answering, allege on information and belief that long before any invention by said Bell of the alleged improvement specified as his invention in said Letters Patent

numbered 174,465, the same was described in the following printed publications, viz.: —

"Electricity and Magnetism," by —— Jenkins, published in London, England, and in the city of New York, in the year 1873, at page 334. "Der Elektromagnetische Telegraph," by H. Schellen, published in Brunswick, Germany, in the year 1867, at pages 468 and 469. "The Electric Telegraph," by R. Sabine, published at London, England, in the year 1867, at pages 45 and 46. "The Electric Telegraph," by Dr. Lardner, new edition, revised by E. B. Bright, published in said London, in the year 1867, at pages 164–165, 166 and 167. "Die Neueren Apparate der Akustic, von Dr. Prof. Fr. Jos. Pisko, Wien, 1865." "L'Eco d'Italia, 1860." "Lehr buch der Technischen Physik," by Dr. Hessler-Pisko, published at Vienna, 1866, Vol. I., page 648. And also other printed publications which are now unknown to these defendants, but which, when known, these defendants pray leave by proper amendments to insert in this answer.

VII. And these defendants, further answering, say that they are advised and aver that the specification of said Letters Patent numbered 174,465 does not sufficiently describe the things attempted to be covered by the claims thereof, to enable persons skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct and use the same, and that the alleged improvements attempted to be patented in the said Letters Patent did not involve or require invention, and did not differ in any patentable respect from what was, before said alleged invention, known and used in this country or described in patents and printed publications.

VIII. And these defendants, further answering, on information and belief deny that said Bell was the original and first inventor of the alleged improvement specified as his invention in said Letters Patent numbered 186,787, and aver that long prior to any invention thereof by him, the same was known to and used by the following persons at the following places, to wit: —

By whom used.	Residence.	Where used or known.
Elisha Gray	Highland Park, Ill.	Oberlin and Cleveland, Ohio, Highland Park and Chicago, Ill., and New York City.
Thomas A. Edison	Menlo Park, N. J.	Menlo Park, N. J, and New York City.
Amos E. Dolbear	Somerville, Mass.	Somerville, Mass.
Alfred G. Holcomb	Granby, Conn.	New York City, N. Y.
Phil. H. Vanderweyde	New York City, N. Y.	New York City, N. Y.
W. F. Channing	Providence, R. I.	Providence, R. I.
U. S. Telephone Co.	Pittsburg, Pa.	Pittsburg, Pa.
Geo. A. Hamilton	Elizabeth, N. J.	Pittsburg, Pa.
Ashael K. Eaton	Brooklyn, N. Y.	Brooklyn N. Y.
Edward Farrar	Keene, N. H.	Keene, N. H.
Antonio Meucci	Clifton, Staten Island.	Staten Island and New York City.
Charles Bourseuls	France.	France.
Phil Reis	Friedrichsdorf, Germany	Friedrichsdorf and Frankfort, Germany.
W. L. Voelker	Morton, Delaware Co. Pa.	Morton, Delaware Co., Pa., Chicago, and other places.
John H. Irwin	Morton, Pa.	Philadelphia, Penn.

And also by numerous other persons whose names and residences are now unknown to these defendants, but which when known, these defendants pray leave by proper amendments to insert in this answer.

And these defendants, further answering, on information and belief aver that long before any invention by said Bell of the alleged improvement specified as his invention in said Letters Patent numbered 186,787, the same was described in and patented by the following Letters Patent, viz.: Letters Patent granted by the government of Great Britain, in the year 1874, to J. H. Johnson, dated July 29, 1874, and numbered 2,646; Letters Patent granted by the Patent Office of the Dominion of Canada, in the year 1875, to Elisha Gray, dated July 7, 1875, numbered 4,749; Letters Patent granted by the United States, in the year 1875, to Elisha Gray, dated July 27, 1875, numbered 166,095; Letters Patent granted by the United States in the year 1876, to Elisha Gray, dated April 11, 1876, numbered 175,971; and also other Letters Patent which are now unknown to these defendants, but which, when known, these defendants pray leave by proper amendments to insert in this answer.

And these defendants, further answering, on information and belief aver that long before any invention by the said Bell of the alleged improvement specified as his invention in said Letters Patent numbered 186,787, the same was described in the following printed publications, viz.: —

"Der Elektromagnetische Telegraph," by Dr. H. Schellen, pub-

lished at Brunswick, Germany, in the year 1867, at pages 411, 412, 413, 414, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 468 and 469. "Zeitschrift des Deutsch-Osterreichischen Telegraphen-Verein," published at Berlin, Prussia, in the year 1862, Vol. IX., at page 25. "The Electric Telegraph," by R. Sabine, published in London, England, in the year 1867, at pages 136, 137 and 138. "The Telegraphic Journal," published in said London, in the year 1872, Vol. I., at page 4. "Electricity," by R. M. Ferguson, published in said London, and Edinburgh, Scotland, in the year 1867, at pages 257 and 258. "The Telegrapher," published in said city of New York, in the year 1869, Vol. V., No. 39, at page . "The Manufacturer and Builder," published in said city of New York, in the year 1869, Vol. I., at page 129. "Wonders of Electricity," by J. Baile, published in said city of New York, in the year 1872, at pages 140, 141, 142 and 143. "The Telegraphic Journal, published at said London, in the year 1875, Vol. III., at pages 286, 287 and 288. "Die Neueren Apparate der Akustic, von Dr. Prof. Fr. Jos. Pisko Wien, 1865. "L' Eco d'Italia," 1860. "Lehrbuch der Technischen Physik," by Dr. Hessler-Pisko, published at Vienna, 1866, Vol. I., page 648. And also in other printed publications which are now unknown to these defendants, but which, when known, these defendants pray leave by proper amendments to insert in this answer.

IX. And these defendants, further answering, say that they are advised and aver that the specification of said Letters Patent numbered 186,787 does not sufficiently describe the thing attempted to be covered by the claims thereof to enable persons skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct and use the same, and that the alleged improvements attempted to be patented in the said Letters Patent did not involve or require invention, and did not differ in any patentable respect from what was before said alleged invention known and used in this country, or described in patents and printed publications.

And these defendants, further answering, on information and belief say that there is no mechanical combination between the ele-

ments constituting the sixth claim of said Letters Patent, numbered 186,787, and that no invention was required to produce the same.

X. And these defendants, further answering, say that they are not informed, save by said bill, whether or not instruments known as Bell telephones and in instruments known as Blake transmitters have been introduced into public use, as alleged in said bill, and whether or not parties have been notified to desist from making, selling or using telephones as alleged in said bill, and they leave the complainants to make such proof thereof as they may be advised.

XI. And these defendants, further answering, say that they are not informed save by said bill whether or not the decrees and orders mentioned in said bill of complaint were obtained as alleged therein, and they leave the complainants to make such proof thereof as they may be advised; but these defendants on information and belief aver that there has been no final adjudication or decree upon the merits, sustaining the validity of the patents in the bill of complaint mentioned.

XII. And these defendants, further answering, deny that the assumed rights of said Bell have never been publicly or openly violated, with exceptions alleged in said bill; and as to the suit pending against Peter A. Dowd, mentioned in said bill, these defendants on information and belief aver that said suit is still pending, and no final adjudication has been obtained therein, but that merely a temporary settlement has been made therein, which in no way admits the validity of the patents granted to said Bell, and numbered respectively 147,465 and 186,787.

XIII. And these defendants, further answering, deny that at the City of New York or elsewhere they have, or either of them has, at any time unlawfully and wrongfully made or caused to be made, used or caused to be used, sold or caused to be sold, telephones embracing and containing the invention and improvements, or any of them, set forth and described in said Letters Patent numbered 147,465 and 186,787, or that these defendants have, or either of them has, infringed any exclusive rights or privileges of or vested in the complainants whatever, or that they have inflicted any damages upon the said complainants, or that they have realized any gains or profits by means of such alleged infringments.

XIV. And these defendants pray the same benefit of the facts and things herein set forth as if for the reason thereof they had demurred to said bill where a demurrer would have been proper, and the same benefit thereof as if they had specially pleaded to the said bill where a special plea would have been proper.

XV. Therefore these defendants deny the equity of said complainants' bill, and that the complainants are entitled to the relief in said bill prayed, or any part thereof without this; that there is any other matter, cause or thing in said bill contained, material or necessary for the defendants to make answer unto, and not hereinbefore sufficiently answered, confessed, traversed, denied or avoided, is true, to the knowledge or belief of these defendants.

Wherefore these defendants pray they may be hence dismissed with their costs and charges in this behalf most wrongfully sustained.

CHAS. W. WEST,
Defendants' Solicitor.
EDMUND WETMORE,
of Counsel.

ASHAEL K. EATON,
C. T. TOMPKINS,
EATON TELEPHONE Co.
C. T. TOMPKINS, *Pres.*

SOUTHERN DISTRICT OF NEW YORK } ss.
CITY AND COUNTY OF NEW YORK, }

Ashael K. Eaton and Cornelius T. Tompkins being duly sworn, say, and each for himself says, that the foregoing answer is true of his own knowledge except as to the matters therein stated on information and belief, and that as to those matters he believes it to be true. And the said Tompkins further says that he is the President of the defendant, the Eaton Telephone Company, and signs and verifies this answer on behalf of said company.

ASHAEL K. EATON.
C. T. TOMPKINS.

Subscribed to and sworn before me this eighteenth day of September, 1880, as to Ashael K. Eaton, and this second day of September as to C. T. Tomkins.

JOHN H. IVES,
Notary Public, Kings Co.
Cert. filed in N. Y. Co.

[SEAL]

[ENDORSED.]

U. S. CIRCUIT COURT,

SOUTHERN DIST. OF N. Y.

THE AMERICAN BELL TELEPHONE CO. AND THE METROPOLITAN TELEPHONE AND TELEGRAPH CO,

vs.

ASHAEL K. EATON, CORNELIUS TOMPKINS, THE EATON TELEPHONE COMPANY, *impleaded with others.*

ANSWER.

CHARLES W. WEST, *Solicitor for Defdts.*
25 Nassau St., N. Y. City.

U. S. CIRCUIT COURT.
[FILED SEP. 6, 1880.]
JOHN I. DAVENPORT, *Clerk.*

COMPLAINANTS' REPLICATION.

CIRCUIT COURT OF THE UNITED STATES,
SOUTH: DISTRICT OF NEW YORK.

IN EQUITY.

AMERICAN BELL TELEPHONE CO. ET AL., *Complainants,*

vs.

ASHAEL K. EATON, ET AL., *Defendants.*

The replication of the complainants to the answer of Asbael K. Eaton, Cornelius T. Tompkins and Eaton Telephone Co., defendants.

These repliants, saving and reserving unto themselves all and all manner of advantage of exception to the manifold insufficiences of the said answer, for replication thereunto, say that they will aver and prove their said bill to be true, certain and sufficient in the law to be answered unto; and that the said answer of the defendants is uncertain, untrue and insufficient to be replied unto by these repliants without this; that any other matter or thing whatsoever in the said answer contained, material or effectual in the law to be replied unto, confessed and avoided, traversed or denied, is true. All which matters and things these repliants are and will be ready to aver and

prove as this Honorable Court shall direct, and humbly pray as in and by their said bill they have already prayed.

DICKERSON & DICKERSON,
Complainants' Solicitors.

[ENDORSED]

U. S. CIRCUIT COURT.
SO: DISTRICT OF NEW YORK.

IN EQUITY.

AMERICAN BELL TELEPHONE COMPANY ET AL.
vs.
ASHAEL K. EATON ET AL.

REPLICATION.

DICKERSON & DICKERSON, *Complainants' Solicitors,*
N. Y. Staats Zeitung Building, City Hall Square, New York.
C. W. WEST, *Solr. for Defts,*
95 Nassau St.

U. S. CIRCUIT COURT.
[FILED SEP. 22, 1880.]
JOHN I. DAVENPORT, *Clerk.*

At a stated term of the Circuit Court of the United States for the southern district of New York, held at the United States Circuit Court rooms in the city of New York, on the twenty-fifth day of March, 1882.

Present: Hon. HOYT H. WHEELER, *District Judge.*

THE AMERICAN BELL TELEPHONE COMPANY AND THE METOPOLITAN TELEPHONE AND TELEGRAPH COMPANY
v.
ASHAEL K. EATON, CORNELIUS TOMPKINS, THE EATON TELEPHONE COMPANY, ET AL.

This cause came on to be heard at the October term, 1881, upon the bill, answer, replication and proofs. Whereupon it is now, to wit, ordered, adjudged and decreed that Alexander Graham Bell is the

original and first inventor of the invention specified in the fifth claim of the patent No. 174,465, granted to said Bell, March 7, A. D. 1876, and the fifth, sixth and eighth claims of the patent No. 186,787, granted to said Bell, Jan. 30, 1877. No adjudication is made as to any other claims that the said patents are good and valid patents, so far as said claims are concerned, and the complainants waiving a reference to a master to ascertain profits and damages, and accepting nominal damages, it is further ordered that the defendants pay to the plaintiffs $1.00 as profits and damages, and also the costs to be taxed, and that they be perpetually enjoined from further infringing the said claims of said patents.

HOYT H. WHEELER.

A copy. JOSEPH M. DEND, *Clerk.*

[ENDORSED.]

U. S. CIRCUIT COURT,
SO. DIST. OF NEW YORK.

IN EQUITY.

THE AMERICAN BELL TELEPHONE COMPANY ET AL.
vs.
ASHAEL K. EATON ET AL.

FINAL DECREE.

DICKERSON & DICKERSON,
For Complnts,
New York.

U. S. CIRCUIT COURT.

Filed Mar. 25, 1882.
JOSEPH M. DEND, *Clerk.*

UNITED STATES OF AMERICA,
SOUTHERN DISTRICT OF NEW YORK, } ss.

I, Timothy Griffith, clerk of the Circuit Court of the United States for the Southern District of New York, do hereby certify that the foregoing are true and correct copies of the original bill, answer, replication and final decree, now on file and remaining of record in

my office in the suit in equity entitled "The American Bell Telephone Company et al. *v.* Ashael K. Eaton et al."

In witness whereof, I have subscribed my name and have caused the seal of the said Court to be hereunto affixed, this twenty-ninth day of September, in the year of our Lord one thousand eight hundred and eighty-five, and of the Independence of the United States of America the one hundred and tenth.

[SEAL] TIMOTHY GRIFFITH, *Clerk.*

(XX)

Circuit Court of the United States.

DISTRICT OF MASSACHUSETTS.

No. 1424.

AMERICAN BELL TELEPHONE COMPANY *et al.*

v.

ALBERT SPENCER *et al.*

OPINION OF THE COURT.

[JUNE 27, 1881.]

LOWELL, J.

The bill alleges an infringement of two patents, granted to Alexander Graham Bell. The defendants admit that they have infringed some valid claims of the second patent, but the plaintiffs are not content with this admission; they rely besides upon the fifth claim of the first patent, which is much more comprehensive in its scope.

Patent No. 174,465, issued to Bell, dated March 7, 1876, is entitled "Improvement in Telegraphy," and is said in the specification to consist in "the employment of a vibratory, or undulatory current of electricity in contradistinction to a merely intermittent or pulsatory current, and of a method of and apparatus for producing electrical undulations upon the line wire." The patentee mentions several advantages which may be derived by the use of this undulatory current, instead of the intermittent current, which continually makes and breaks contact, in its application to multiple telegraphy, that is, sending several messages, or strains of music, at once over the same wire; and the possibility of conveying sounds, other than musical notes. This latter application is not the most prominent in the specification; though, as often happens, it has

proved to be of surpassing value. This part of the invention is shown in figure 7, of the drawings, and is thus described in the text:

"The armature, *c*, Fig. 7, is fastened loosely by one extremity to the uncovered leg, *d*, of the electro-magnet, *b*, and its other extremity is attached to the centre of a stretched membrane, *a*. A cone, A, is used to convey sound vibrations upon the membrane. When a sound is uttered in the cone, the membrane, *a*, is set in vibration, the armature, *c*, is forced to partake of the motion, and thus electrical undulations are created upon the circuit *E*, *b*, *e*, *f*, *g*. These undulations are similar in form to the air vibrations caused by the sound; that is, they are represented graphically by similar curves. The undulatory current passing through the electro-magnet, *f*, influences its armature, *h*, to copy the motions of the armature, *c*. A similar sound to that uttered in A, is then heard to proceed from L."

With the figure 7 before us, this description is readily understood. A cone of pasteboard, or other suitable material, has a membrane stretched over its smaller end; at a little distance is a piece of iron magnetized by a coil through which is passing a current of electricity. When sounds are made at the mouth of cone, A, the membrane vibrates like the drum of a human ear; and the armature, which is directly in front of the magnet, vibrates with the membrane, and its movements cause pulsations of electricity like those of the air which excited the membrane, to pass over the wire; and the wire stretches to another similar magnet and cone with its membrane and armature. The second armature and membrane take up the vibrations and make them audible by repeating them into the condensing cone, L, which translates them into vibrations of the air.

The defendants insist that the instrument represented in figure 7 will not transmit articulate speech; that this great result has been reached by Mr. Bell entirely through the improvements described in his second patent, such as the substitution of a metal plate for the stretched membrane, and some others.

The importance of the point is, that if Bell, who is admitted in this case to be the original and first inventor of any mode of transmitting speech, had not completed his method, and put it into a working form when he took his first patent, he may lose the benefit of his invention; because, in his second patent, he makes no broad claim to the method or process, but only to the improvements upon a process assumed to have been sufficiently described in his first patent.

There is some evidence that Bell's experiments with the instrument, described in figure 7, before he took out his patent, were not entirely successful; but this is now immaterial; for it is proved that the instrument will do the work, whether the inventor knew it or not, and in the mode pointed out by the specification.

The fifth claim of this patent is for

"The method and apparatus for transmitting vocal, or other sounds, telegraphically, by causing electrical undulations, similar in form to the vibrations of the air accompanying the said vocal, or other sounds, substantially as set forth."

The defendants use a method and apparatus for transmitting vocal sounds, which resemble those of the plaintiffs in producing electrical undulations copied from the vibrations of a diaphragm, and sending them along a wire to a similar receiver at the other end. The specific method of producing the electrical undulations is different. It is made on the principle of the microphone, which has been very much improved since the date of the first Bell patent.

If the Bell patent were for a mere arrangement, or combination of old devices, to produce a somewhat better result in a known art, then, no doubt, a person who substituted a new element not known at the date of the patent might escape the charge of infringement. But Bell discovered a new art, — that of transmitting speech by electricity, — and has a right to hold the broadest claim for it which can be permitted in any case; not to the abstract right of sending sounds by telegraph, without any regard to means, but to all means and processes which he has both invented and claimed.

The invention is nothing less than the transfer to a wire of electrical vibrations like those which a sound has produced in the air. The claim is not so broad as the invention. It was, undoubtedly, drawn somewhat carefully in view of the decision in *O'Reilly* v. *Morse*, 15 How. 62, and covers the method and apparatus, that is, any process and any apparatus of substantially similar character to those described. The patent points out distinctly, that the undulations may be produced in other modes besides the vibration of an armature in front of a magnet; and the defendants make use of a mode not wholly unknown at that time, though much improved, in creating their undulations.

It seems to me that the defendants use both the method and the apparatus of Bell. The essential elements of the method are the production of what the patent calls undulatory vibrations of elec-

tricity to correspond with those of the air, and transmitting them to a receiving instrument capable of echoing them. Granting that the defendants' instrument for converting the vibrations of the diaphragm into vibrations of electricity is an improvement upon that of the plaintiffs, still it does the same sort of work, and does it in a mode not wholly unknown at the date of the patent; though I do not consider that material.

An apparatus made by Reis, of Germany, in 1860, and described in several publications before 1876, is relied on to limit the scope of Bell's invention. Reis appears to have been a man of learning and ingenuity. He used a membrane and electrodes for transmitting sounds, and his apparatus was well known to curious inquirers. The regret of all its admirers was, that articulate speech could not be sent and received by it. The deficiency was inherent in the principle of the machine. It can transmit electrical waves along a wire, under very favorable circumstances, not in the mode intended by the inventor, but one suggested by Bell's discovery, but it cannot transmute them into articulate sounds at the other end, because it is constructed on a false theory, and the delicacy of use required to make it perform part of the operation is fatal to its possible performance of the other part. A Bell receiver must be used to gather up the sound before the instrument can even now be adapted to a limited practical use. It is like those deaf and dumb pupils of Professor Bell, who could be taught to speak, but not to hear. That was all, but it was enough. A century of Reis would never have produced a speaking telephone by mere improvement in construction.

I am of opinion that the fifth claim of patent No. 174,465, is valid, and has been infringed.

The statute declares that if a patentee has claimed too much in any part of his patent he shall not recover costs, and it has been argued that certain claims of these patents, not relied on by the plaintiffs, are too broad. In this stage of the case the question of costs does not arise; but I may as well say, that there is not sufficient evidence in the record to enable me to find whether these claims are valid or not; and that the statute does not mean that claims not in issue should be contested for the mere purpose of settling the costs. More expense might be incurred in such a mode of trial than depended upon the main issue.

Decree for the complainants.

DECREE FOR PERPETUAL INJUNCTION.

CIRCUIT COURT OF THE UNITED STATES,

DISTRICT OF MASSACHUSETTS.

IN EQUITY.

AMERICAN BELL TELEPHONE COMPANY ET AL.

v.

ALBERT L. SPENCER ET AL.

DECREE.

This cause came on to be heard upon the bill, answer, replication and proofs, and was argued by counsel and considered by the Court, whereupon it is now, to wit, Aug. 27, 1881, ordered, adjudged and decreed that Alexander Graham Bell is the original and first inventor of the invention specified in the fifth claim of the patent numbered 174,465, granted to said Bell, March 7, A. D. 1876, and the fifth, sixth and eighth claims of the patent numbered 186,787, granted to said Bell, Jan. 30, 1877, being the claims in respect of which the proofs were taken; that the said patents are good and valid patents therefor; and the complainants waiving a reference to a master to ascertain profits and damages, and accepting nominal damages, it is further ordered that the defendants pay to the plaintiff the sum of one dollar as profits and damages, and also costs taxed at , and that they be perpetually enjoined from further infringing the said patents.

By the Court,

ALEX. H. TROWBRIDGE,
Deputy Clerk.

Attest: ALEX. H. TROWBRIDGE,
Deputy Clerk.

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First Single Tone Transmitter (cut) . . offered, 8; referred to, 19, 20, 22, 29, 43, 46
Closed Circuit Single Tone Transmission Apparatus (cut) . offered, 8; referred to, 20, 23, 26, 29, 30, 35, 43, 51
Animal Tissue Violin Receiver (cut) . . . . . offered, 9; referred to, 9, 42, 43
Animal Tissue Revolving Plate Receiver (cut) . . . . offered, 9; referred to, 9, 43
Paper Drum Receiver (cut) . . . . . offered, 10; referred to 9, 43
Concave Metallic Diaphragm Magnet Receiver (cut) . . . offered, 10; referred to 9, 12, 28, 43, 45, 47, 53
Diaphragm Box Magnet Receiver (cut) . offered, 11; referred to, 9, 13, 28, 43, 45, 47
Wooden Sounding Box Magnet Receiver (cut) . . . . offered, 11; referred to, 9, 13, 15, 24, 25, 28, 43, 45
Two Octave Transmitter (cut) . . . . . offered, 11; referred to, 43
One Octave Transmitter (cut) . . . . . offered, 11; referred to, 19, 43
Second Single Tone Transmitter (diagram) . . . . . offered, 12; referred to, 43
Third Single Tone Transmitter (diagram) . . . . . offered, 12; referred to, 43
Multiple Transmitter of 1875 (cut) . . . . . offered, 14
(See Reed Transmitter Patent.)
Mechanical Transmitter (cut) . . . . . offered, 16; referred to, 45
Speaking Telephone Caveat Original Sketch . offered, 18; referred to, 21, 45, 48, 49
Glass Resonator (cut) . . . . . offered, 25; referred to, 35, 38, 39, 40, 47
Circuit Connections (diagram) . . . . . offered, 35; referred to, 36
Bath Tub Experiment (cut) . . . . . offered, 42
Notice 56
Stipulations:
Bell vs. Dowd Record, "Telephone Suits," offered in evidence and stipulated in . 5
As to recall of witnesses 5, 6

In the United States Patent Office.

THE SPEAKING TELEPHONE INTERFERENCES.

EVIDENCE FOR ELISHA GRAY.

In the matter of the General Speaking Telephone Interferences, A, B, C, D, E, F, G, I, J, and L, declared March 26, 1878, May 27, 1879, and January 21, 1880, between —

Letters patent of —

A. G. Bell, No. 174,465, March 7, 1876.

A. G. Bell, No. 186,787, January 30, 1877,

and the respective applications of —

E. Berliner, filed June 4, 1877.

A. E. Dolbear, filed October 31, 1877.

T. A. Edison, case 130, filed April 27, 1877.

" " " 144, " September 5, 1877.

" " " 145, " December 13, 1877.

" " " 148, " December 24, 1877.

Elisha Gray, " 1, " October 29, 1877.

" " " 2, " October 29, 1877.

" " " 3, " October 29, 1877.

" " " 4, " January 17, 1878.

J. W. McDonough, filed April 10, 1876.

Geo. B. Richmond, filed August 24, 1877.

Wm. L. Voelker, filed May 19, 1879.

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Deposition of witnesses examined on behalf of Elisha Gray, pursuant to the annexed notice, at the Clifton House, Chicago, Illinois, on Wednesday, May 5, 1880. Present:

William D. Baldwin, on behalf of Elisha Gray.

J. J. Storrow, on behalf of A. G. Bell and Emile Berliner.

L. W. Serrell, on behalf of Thomas A. Edison.

No appearance for the other parties.

Counsel for Gray offers in evidence the following documentary matter, printed copies of which it is agreed may be substituted for the originals or certified copies thereof, to wit:

1. The file wrapper, contents and drawing in the matter of the application of Elisha Gray, for letters patent of the United States, granted July 27, 1875, as No. 166,096, marked "Exhibit Animal Tissue Application."

2. The file wrapper, contents and drawing in the matter of the application of Elisha Gray, for letters patent No. 166,095, granted July 27, 1875, marked "Exhibit Magnet Receiver Application."

3. Reissued letters patent granted to Elisha Gray January 28, 1879, No. 8559, on patent 166,095, and marked "Exhibit Magnet Receiver, Art Division."

4. Reissued letters patent granted to Elisha Gray January 28, 1879, No. 8559, on patent 166,095, and marked "Exhibit Magnet Receiver, Apparatus Division."

5. Letters patent No. 165,728, granted to Elisha Gray July 20, 1875, marked "Exhibit Reed Transmitter Patent."

6. Letters patent No. 166,094, granted to Elisha Gray July 27, 1875, marked "Exhibit Tuned Bar Receiver Patent."

7. Letters patent No. 173,460, granted February 15, 1876, to Elisha Gray, marked "Exhibit Organ Pipe Transmitter Patent."

8. Letters patent No. 175,971, granted to Elisha Gray April 11, 1876, marked "Exhibit Sounding Box Receiver Patent."

9. Letters patent No. 179,549, granted to Elisha Gray July 4, 1876, marked "Exhibit Printer Patent."

10. Letters patent No. 186,340, January 16, 1877, to Elisha Gray, marked "Exhibit Closed Circuit Patent."

11. Reissued letters patent No. 8869, August 26, 1879, to Elisha Gray, marked "Exhibit Closed Circuit Reissue, Art Division."

12. Reissued letters patent No. 8870, granted August 26, 1879, to Elisha Gray, marked "Exhibit Closed Circuit Reissue, Apparatus Division."

13. Letters patent No. 198,379, granted December 18, 1877, to Elisha Gray, marked "Exhibit Gray Double Bar Magnet Patent."

14. Letters patent No. 205,378, granted June 25, 1878, to Elisha Gray, marked "Exhibit Common Receiver Patent."

15. Letters patent No. 210,776, granted to Elisha Gray December 10, 1878, marked "Exhibit Revolving Drum Telephone Patent."

16. The file, contents and drawing of Gray's speaking telephone caveat, filed February 14, 1876, marked "Exhibit Gray Caveat."

17. The file, contents and drawing of Gray's application, filed October 29, 1877, Case 1, marked "Exhibit Speaking Telephone, Art Application."

18. The file, contents and drawing of Gray's application, filed October 29, 1877, Case 2, marked "Exhibit Liquid Transmitter Telephone Application."

19. The file, contents and drawing of Gray's application, filed October 29, 1877, Case 3, marked "Exhibit Concave Diaphragm Receiver."

20. The file, contents and drawing of Gray's application, Case 4, filed January 17, 1878, marked "Exhibit Supplementary Magnet Telephone Application."

Counsel for Gray offers in evidence the record in the case of *Bell Telephone Company et al.* v. *Peter A. Dowd*, in the Circuit Court of the United States for the District of Massachusetts, commonly known as the "Telephone Suits." and each deposition or piece of evidence embodied in or constituting a part of said record will be used and relied

upon as if taken in these interferences, and may be so used by any party hereto. He also offers to recall for further cross-examination, at any time during the present taking of testimony on behalf of Gray, any witness whose deposition was taken on behalf of the defendant in said suit, if such recalls be requested by any other party.

Agreed to by the undersigned, each for the interferences to which he is a party.

W. D. BALDWIN, *of counsel for Gray.*
J. J. STORROW, *for Bell, Berliner & Bell Telephone Co.*
LEMUEL W. SERRELL, *Attorney for T. A. Edison et al.*
GEO. W. DYER, *for Voelker.*
FRANK L. POPE, *for Dolbear.*
GRIDLEY & COMPANY, *for McDonough.*

Counsel for Bell gives notice that he will recall for further cross-examination during the time allotted Mr. Bell for taking testimony in chief in these interferences, any witness whose deposition was taken on behalf of the plaintiffs in said suit, upon reasonable request for such recall from any party to these interferences.

J. J. STORROW, *for Bell.*

Counsel for Gray produces for inspection the following exhibits, put in evidence in the telephone suits above mentioned, marked as follows:

1. Animal tissue violin receiver.
2. Animal tissue revolving plate receiver (drum telephone).
3. Concave diaphragm magnet receiver (wash-basin receiver).
4. Closed circuit single tone transmission apparatus.
5. Wooden sounding-box magnet receiver (mouse-trap).
6. Diaphragm box magnet receiver (tin-dipper receiver).
7. Mechanical transmitter.
8. Resonant box magnet receiver (blacking box).

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DEPOSITION OF WILLIAM M. GOODRIDGE:

William M. Goodridge being duly sworn, doth depose and say, in answer to the interrogatories proposed to him by William D. Baldwin, counsel for said Elisha Gray, as follows, to wit:

Int. 1. — State your name, age, residence and occupation?

A. — My name is William M. Goodridge; my age, 44 years; residence, Highland Park, Lake County, Illinois; occupation, instrument maker.

Int. 2. — What has been your special occupation during the past six years?

A. — I have been assistant to Mr. Elisha Gray, in the development of his electrical inventions.

Int. 3. — How long have you known Elisha Gray?

A. — About eight years.

Int. 4. — State whether you are the same witness who testified in the telephone suits of *Bell Telephone Co.* v. *Dowd*, and whether all the statements contained in your two depositions in that case are true?

A. — I am, and they are.

Int. 5. —State what instrument you made first for Elisha Gray, for the electrical transmission of musical tones?

A. — I made a two-tone transmitter, to serve as a model to accompany applications for patents, said applications being for Gray's animal tissue patent and magnet receiver patent; the animal tissue patent is numbered 166,096, dated July 27, 1875; application originally filed April 18, 1874, and renewed January 19, 1875. The other patent is numbered 166,095; application originally filed June 27, 1874, renewed January 19, 1875, granted July 27, 1875.

This apparatus is shown in the drawings accompanying these patents.

The animal tissue patent is printed on page 615, part 2, "Telephone Suits;" the application for it on page 621 of the same volume.

The magnet receiver patent is printed on page 579 of the same volume, and the application for it on page 583.

The subject-matter of these two patents is also found in J. H. Johnson's English patent, dated July 29, 1874, and found on page 566 of the same volume.

These applications constitute Exhibits "Animal Tissue Application" and "Magnet Receiver Application" of this interference.

[*Recess.*]

Int. 6. — When was this two-tone transmitter made?

A. — It was commenced April 4, 1874, and finished within two or three days.

Int. 7. — Was it a working instrument or apparatus?

A. — It was.

Int. 8. — State what you know in regard to its being practically operated?

A. — It was used sufficiently to test its working, and proving practically a working instrument, it was soon after sent to Washington.

Int. 9. — Was this apparatus made by you personally, or under your direction?

A. — It was made by me personally.

Int. 10. — What receiver, if any, did you use in connection with it?

A. — A thin plate of metal.

Int. 11. — State what transmitter, if any, you next made for Gray?

A. — I made an instrument for transmitting a single tone, a description of which can be found on page 70, part I., "Telephone Suits." A cut of it may be found on page 762, part II., of the same.

(*Wood cut offered in evidence, marked "Exhibit Gray's First Single Tone Transmitter."*)

Int. 12. — At what time did you make this single tone transmitter?

A. — In the early part of May, 1874.

Int. 13. —State what circuit connections and receivers were used in connection with this transmitter?

A. — It was used in a closed circuit, shown in cut on page 768, part II., "Telephone Suits," and described in the answer to the 71st interrogatory, on page 85, part I.

(*Wood cut offered in evidence, marked "Exhibit Gray's Closed Circuit Single Tone Transmission Apparatus."*)

It was used in connection with all the various forms of receivers, namely, the animal tissue receiver, two improved forms of animal tissue receiver, a paper drum receiver, a magnet receiver with a hollow tin box placed on or near the poles ("blacking box" receiver; another form of magnet receiver, consisting of a wash basin mounted near the poles of a magnet; another form of magnet receiver, the magnets enclosed in a tin dipper; another form of magnet receiver, consisting of an iron plate mounted upon a sounding box.

Int. 14.—State what the animal tissue receiver referred to first in the above answer was.

A.—It was a thin plate of metal used in the manner represented in Gray's patent, No. 166,096.

Int. 15.—State what the first of the two improved forms of animal tissue receiver, referred to in answer 13, was, and explain the manner in which it was used.

A.—It was Gray's animal tissue violin receiver, described in the answer to the twenty-first interrogatory, page 72, part I., "Telephone Suit," and shown in a cut on page 763, part II.

(*Wood cut introduced in evidence, marked "Exhibit Gray's Animal Tissue Violin Receiver."*)

Int. 16.—Answer the same question as to the second of said receivers.

A.—This was Gray's animal tissue revolving plate receiver, described in answer to interrogatory 23, on page 72, part I., "Telephone Suits," and shown in cut on page 764, part II.

(*Wood cut introduced in evidence, marked "Exhibit Gray's Animal Tissue Revolving Plate Receiver."*)

This receiver is also shown in Gray's patent, No. 210,776, patented December 10, 1878, "Exhibit Gray's revolving drum telephone patent" in this case, which patent is also found on page 678, part II., "Telephone Suits."

Int. 17.—Answer the same question as to the "paper drum receiver."

A.—The paper drum receiver was described in the answer to interrogatory 28, page 73, part I., "Telephone Suits," and shown in a cut on page 765, part II.

(*Wood cut introduced in evidence, marked "Exhibit Paper Drum Receiver."*)

Int. 18.—Answer the same question as to the "magnet receiver with a hollow tin box placed on or near the poles."

A.—This magnet receiver is described in the answer to the 29th interrogatory, page 74, part I., "Telephone Suits," and shown in Gray's patent, 166,095, patented July 27, 1875; the application for this patent is also an exhibit in these interferences.

Int. 19.—Answer the same question as to "another receiver, consisting of a wash-basin mounted near the poles of a magnet."

A.—This receiver is described in the answer to the 36th interrogatory, page 76, part I. "Telephone Suits," and is shown in a cut on page 766, part II.

(*Wood cut introduced in evidence, marked "Exhibit Gray's Concave Metallic Diaphragm Magnet Receiver."*)

It is also shown in Gray's patent, No. 205,378, patented June 25, 1878, which patent is also an exhibit in these interferences marked "Exhibit Common Receiver Patent." It is also shown in Gray's Concave Diaphragm Receiver Speaking Telephone Application, on page 747, part II. "Telephone Suits," which application is also an exhibit in these interferences, marked "Gray's Concave Diaphragm Receiver Application."

Adjourned to Thursday, May 6, at 10 a. m.

THURSDAY, May 6—10 a. m.

Same appearances as yesterday.

Int. 20.—Answer the same question as to "another form of magnet receiver, the magnets enclosed in a tin dipper."

A.—This receiver is described in answer to the 77th interrogatory, page 87, part I., "Telephone Suits," and shown in cut on page 770, part II.

(*Wood cut introduced in evidence, marked "Exhibit Diaphragm Box Magnet Receiver."*)

Int. 21. — Answer the same question as to "another form of magnet receiver, consisting of an iron plate mounted upon a sounding box."

A. — This receiver is described in answer to the 75th interrogatory on page 86, part I., "Telephone Suits," and shown in cut on page 769, part II. The thin octagonal plate of iron mentioned in the description is not shown in the cut, but I have an iron plate which will represent it. It is an iron plate 1-16 inch thick, forming an octagon inscribed in a circle of $3\frac{5}{8}$ inches diameter.

(*Wood cut above referred to, introduced in evidence, marked "Exhibit Gray's Wooden Sounding Box Magnet Receiver."*)

(*Iron plate introduced, marked "Exhibit Octagonal Plate."*

Int. 22. — State what transmitters, other than those previously mentioned by you, if any, were made by you in 1874 — prior to August, 1874.

A. — The transmitters constructed prior to August, 1874, are described in the answer to the 38th interrogatory, on page 77, part I., "Telephone Suits," one of which is represented in the cut on page 767, part II., another in the cut on page 190, Prescott's "Speaking Telephone," figure 87; and two others on page 192, same book, figures 88 and 89. These four are named as follows and were constructed in the following order: The "one octave transmitter," first; "two octave transmitter," next; the second and third "single tone transmitter" were made at the same time; one of these figures, 88, in Prescott, had the magnet wrapped with a single coil in the usual way. The other had the magnets wrapped with two coils, like an induction coil, the battery and circuit breaker were in the primary circuit, and the secondary wire went to line. These two Single Tone Transmitters were made in July, 1874.

(*Wood cut first above referred to, introduced in evidence, marked "Exhibit Gray's Two Octave Transmitter"; first wood cut from Prescott, figure 87, put in evidence, marked, "Exhibit One Octave Trans-*

mitter;" diagram corresponding to Prescott, figure 88, *put in evidence as "Exhibit Second Single Tone Transmitter;" diagram corresponding to Prescott, figure* 89, *put in evidence as "Exhibit Third Single Tone Transmitter.")*

Int. 23. — Referring now to the magnet receiver mentioned in your 18th answer, as shown in Gray's patent, 166,095 ("blacking-box") state when, where, and with what circuit connections it was practically worked, to your knowledge.

A. — The first use of this magnet receiver and method of connecting and the place are described in the answers to interrogatories 29, 30, 31, 32 and 33, on pages 74 and 75, part I., "Telephone Suits." Another use is mentioned in answers to interrogatories 41 to 49, inclusive, on pages 79, 80 and 81, same volume. Also in answers to interrogatories 68 to 71, inclusive, pages 84 and 85, same volume. Another use is mentioned in the answer to the 99th interrogatory, page 92, same volume; and another use is mentioned in answer to interrogatories 102 to 108, inclusive, on pages 93 and 94, same volume. I have used this receiver in a great variety of tests and experiments, and in connection with all the various transmitters from the time of its construction to the present time. By this receiver I mean either the original or duplicates of it.

Int. 24. — State when, where, and with what circuit connections the instrument represented by "Exhibit Gray Concave Diaphragm Magnet Receiver" ("wash basin" receiver), was practically worked to your knowledge?

A. — I used this receiver after its completion in July, 1874, in connection with the single tone transmitter, in the manner described in the answer to interrogatory 71, page 85, part I., "Telephone Suits," in various tests and experiments; afterwards assisting in an exhibition mentioned in answer to interrogatories 41 to 49, inclusive, pages 79 to 81; also in exhibitions in London, mentioned in answers to interrogatories 52 to 59, inclusive, pages 81, 82 and 83, part I., same volume. I also used this receiver as described in answers to

interrogatories 99 to 108, inclusive, pages 92, 93 and 94, same volume. I have used this receiver with all the various forms of transmitters.

[*Recess.*]

Int. 25. — State when, where, and with what circuit connections the instrument represented by "Exhibit Diaphragm Box Magnet Receiver" ("tin dipper" receiver) was practically worked, to your knowledge?

A. — I have used it in tests and experiments with all the various forms of transmitters, and also as described in answers to the 79th to 84th interrogatories, both inclusive, on pages 88 and 89, Part I., "Telephone Suits," and also as described in the answers to interrogatories 99 to 108, inclusive.

Int. 26. — State when, where, and with what circuit connections the instrument represented by "Exhibit Gray, Wooden Sounding-Box Magnet Receiver" ("mouse trap") was practically worked, to your knowledge?

A. — I have also used this receiver with all the various forms of transmitters, in tests and experiments, and also as described in answers to interrogatories 75 and 76, on pages 86 and 87, Part I., "Telephone Suits," and also as described in answers to interrogatories 89 to 95, inclusive, on pages 90 and 91, same volume, and also in answer to interrogatory 1, on page 269; and I have assisted in a great number of public exhibitions, using this receiver for receiving melodies.

Int. 27. — State when an instrument or instruments like that represented in "Exhibit Reed Transmitter Patent" was first made and used, to your knowledge, and with what circuit connections and receivers?

A. — These instruments were made in the summer of 1875, and used during the month of September, 1875, in the manner shown in Gray's patents No. 175,971, patented April 11, 1876, and No. 186,340, patented Jan. 16, 1877, and No. 205,378, patented June 25, 1878, and described in answers to interrogatories 89 to 95, inclusive, on pages 90 and 91, part I., "Telephone Suits," and also in answer to interrogatory 1, pages 269, 270, 271 and 272, same volume.

In reference to the use in September, 1875, as shown in the patents named, I refer to the transmitters and not to the receivers shown in

connection with them. One of these transmitters was sent to the Patent Office, accompanying the application filed June 28, 1875, for patent No. 165,728, dated July 20, 1875. A cut of one of these transmitters is shown on page 773, part II., "Telephone Suits."

(*Cut put in evidence, marked "Exhibit Gray's Multiple Transmitter of* 1875.")

This form of transmitter is now in actual use on a telegraphic circuit between Pittsburgh and Columbus, on Mr. Gray's system of Morse Telephonic Telegraphy or Way-Duplex, patented January 1, 1878, patent No. 198,738, and has been for two years or more.

Int. 28.—State when an instrument or intruments like that represented in "Exhibit Organ Pipe Transmitter Patent," was first made and used, to your knowledge, and with what circuit connections and receivers?

A.—This instrument was made in the spring or summer of 1875, and used experimentally in various ways and with various receivers during the summer of 1875. I do not remember any definite uses, but it was intended to be used with any of the receivers, or in the place of any of the other transmitters, either in a closed circuit or in an interrupted circuit. One of these instruments was sent to Washington to serve as a model for an application for patent filed January 8, 1876, patent No. 173,460, dated February 15th, 1876.

I find in a certified copy of the application for this patent, that this was sworn to on the third of January, 1876, before Edward H. Beebe, Notary Public. This instrument is shown and described in specification of Gray's patent, No. 173,460, dated February 15, 1876, and in cut on page 650, Part II., "Telephone Suits," and by Mr. Pope, on page 362, part I., "Telephone Suits."

Int. 29.—State when an instrument, or instruments, like that represented in "Exhibit Gray Tuned Bar Receiver Patent," was first made and used, to your knowledge, and with what circuit connections.

A.—The first instrument of this kind was made in November or December, 1874. Later, during the same winter, a number of these instruments were made, so constructed as to be used either as

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transmitter or receiver. As receivers they are described in Gray's patent, No. 166,094, patented July 27, 1875, and mentioned in answers to interrogatories 72 and 73, page 86, part I., "Telephone Suits," and shown in cut on page 577, part II., and described in a specification for patent, No. 166,094, on said page 577. As receivers, they were used in closed circuit. When used as transmitters, they interrupted the circuit.

Adjourned until Friday, May 7, at 10 a. m.

FRIDAY, May 7, 1880 — 10 a. m.

Same appearances as before.

Int. 30. — State when an instrument or instruments like that represented in Exhibit "Sounding Box Receiver Patent" was made and used, to your knowledge, and with what circuit connections?

A. — It was made in the fall or winter of 1875, and is described in Gray's patent No. 175,971, patented April 11, 1876, and also on pages 651, 652, 653 and 654, part II., "Telephone Suits," and is shown in cuts between pages 652 and 653, same volume. During the winter of 1875 and 1876 several were used in Milwaukee in experiments upon a line 200 miles long, in connection with the tuned bar transmitters, in a closed circuit. At one time we had ten of these receivers and transmitters connected up together, so that ten tones were sent and received simultaneously. A message could be sent by each tone. I do not remember of our sending ten messages at the same time, but do remember sending eight messages simultaneously and having them received and copied by operators. They were connected up in this manner several weeks and were exhibited to a great many persons. In January, 1876, we took a number of the transmitting and receiving instruments to Washington, connected them up in the same manner spoken of above, in the office of W. D. Baldwin, and exhibited them for a number of days to a number of persons who were invited in; among them Prof. Henry, of the Smithsonian Institute; Mr. Wilbur, of the patent office; S. L. Phelps, of Washington, and others. They were also taken to the Army Medical Museum, and exhibited at a meeting of the National Philosophical Society one evening, connected up in the same manner

spoken of above. A month or so later they were taken to Philadelphia and exhibited in the office of Dr. S. S. White, also connected up in the same manner. At the Centennial Exhibition we had eight similar transmitters and receivers connected up in the same manner on exhibition during the continuance of the Exhibition. In the latter part of the summer of 1876, or early in the fall, we equipped a line between Philadelphia and New York, with four transmitters and four receivers at each end, and succeeded in sending four messages in each direction simultaneously. Circuit in all these cases being a closed circuit. We have frequently used four of these transmitters and receivers to illustrate lectures, showing the analysis of tones.

Int. 31. — State the facts connected with the construction and operation of "Gray's Mechanical Transmitter?"

A. — These facts will be found in my answers to interrogatories 168 to 170, inclusive, on pages 107 and 108, part I., "Telephone Suits." A cut of the instrument will be found on page 771, part II.

(*Wood cut put in evidence, marked "Exhibit Gray's Mechanical Transmitter."*)

Int. 32. — State what conversations, if any, you had with Elisha Gray during the years 1874 and 1875, as to the telegraphic transmission of articulate speech?

A. — I do not remember any definite conversation with him, but it was a subject of frequent remark that he had an apparatus capable of receiving articulate speech. Some time in the winter of 1874, after his return from Europe, I saw a letter which he received from some person in England, containing a clipping from some printed paper or book, being a prophecy, so called, of a method of speaking telegraphically. The substance of the letter was that Mr. Gray was fulfilling that prophecy, and we occasionally, during the summer and winter of 1875, had conversations in relation to the manner of constructing an instrument for transmitting articulate speech.

Int. 33. — State what knowledge or information you had, during the period mentioned, as to any apparatus for transmitting articulate speech, contemplated by Mr. Gray?

A.— There was nothing done towards the construction of an instrument for that purpose, to my knowledge, in 1875. These conversations were informal, and were simply in relation as to how it might be done.

Int. 34.— Please answer the same question as to reproducing rhythmical vibrations representing articulate speech?

A.— This is answered by my answers to the 167th and 168th interrogatories, on page 107, Part I., "Telephone Suits."

Int. 35.— Referring to your deposition, answer 75, page 86, Telephone Suit Record, state more fully the facts connected with the octagonal iron plate, referred to as "mounted upon three legs, and used in different ways"?

A.— This plate was one of five made at the same time, but was mounted in a different manner from the others, so as to be used in a variety of ways. Sometimes it was placed upon the sounding-board of a piano, sometimes on a table, and sometimes upon a wooden box. The magnet was mounted upon the upper side of the plate, the plate being screwed firmly to one pole and being separated a little distance from the other pole.

Int. 36.— State which of the various instruments you have mentioned embodied an induction coil in their organization?

A.— The first two-tone transmitter and one of the two single-tone transmitters mentioned in my answer to the 38th interrogatory, on page 78, Part I., "Telephone Suits," and referred to in my answer to the 22d question in this deposition.

Int. 37.— State what was your first knowledge of Gray's liquid transmitter, set forth in his interfering applications cases 1 and 2, and represented more particularly in figure 1 of liquid transmitter telephone application in interference?

A.— My first definite knowledge of this transmitter is that in January or February, 1876, Mr. Gray handed to me a pencil drawing of it, showing it in connection with a receiving instrument, and requested me to take it the draughtsman employed by Mr. Baldwin, and explain it to him, so that he could make a drawing of it for the

Patent Office. This was while Mr. Gray and myself were in Washington, exhibiting the apparatus spoken of in answer to the 30th interrogatory in this deposition. I arrived at Washington on this occasion on the 28th of January, 1876, and remained there until the evening of the 15th of February. I produce the pencil sketch above referred to. I am not sure whether I saw Mr. Gray make it or not. The date and words on it are in his handwriting.

(*A photo-lithograph fac simile of this sketch put in evidence, marked "Exhibit Gray Speaking Telephone Caveat, Original Sketch." The original will be produced on the hearing.*)

[*Recess.*]

Int. 38.—State what knowledge you have as to the construction of a working liquid transmitter, such as is referred to in the preceding question?

A.—I made such an instrument for Mr. Gray in June or July, 1876, in Philadelphia, and experimented with it a number of times in the main building of the Centennial Exhibition about the same time with Mr. Gray, and also in rooms in the building occupied by the Western Union Telegraph Company at that time, corner of Third and Chestnut streets, also with Mr. Gray. This is the instrument referred to by Mr. Gray in answers to cross-interrogatories 110 to 113, inclusive, on pages 138 and 139, Part I., Telephone Suit Record, and also in answers to interrogatories 59 and 60, pages 127 and 128, same volume.

Int. 39.—State what was your first knowledge of the receiving instruments represented in figures 2, 3, and 4 of Gray's Interfering Liquid Transmitter application, and of its subsequent construction and use?

A.—The first knowledge I had of this instrument was in November, 1877, when I had one made from drawings sent to me in Chicago from Washington, to serve as a model for the interfering application, Exhibit Gray Liquid Transmitter Telephone Application. I have used instruments constructed exactly like those represented in figures 2, 3 and 4 mentioned in the question, both for transmitting and reciving articulate speech, with perfect success.

Int. 40. — State which of these exhibits, as to which you have testified, is represented by the reproducing apparatus represented in Gray's Concave Diaphragm Receiver Application?

A. — The Concave Metallic Diaphragm, or "wash basin" magnet receiver, described in answer to 19th interrogatory of this deposition.

Int. 41. — Have you read the various issues in these interferences as defined in the official letters of March 26, 1878, and do you understand the same?

A. — I have, and I do.

Int. 42. — State when, to your knowledge, Mr. Gray first practiced the art of transmitting and reproducing sonorous waves or vibrations of any description, which consists in increasing and decreasing the strength of an electric current traversing a circuit, in such a manner as to produce in said circuit a series of electrical waves or vibrations, precisely corresponding in their intervals of succession and relative amplitudes to the sonorous waves which are to be reproduced at the receiving station or stations?

A. — In May, 1874.

Int. 43. — Specify the apparatus so used in practicing said art.

A. — Mr. Gray's first Single Tone Transmitter, in connection with the Animal Tissue Receiver, "tin plate," and also in connection with the Magnet Receiver with hollow tin box on or near the poles, and also his first One-Octave Transmitter in connection with the Resonant Box Magnet Receiver.

Int. 44. — Were any of the apparatuses referred to in your last answer, arranged and connected up as you have described, adapted for the transmission of articulate speech?

A. — Not when using the transmitter as a transmitter and the receiver as a receiver. When using this apparatus mentioned in the preceding answer, in May, 1874, we were not aware that it was adapted for the transmission of articulate speech, but with our present knowledge we find that it can be used for the transmission and reception of articulate speech without changing the combination or altering the connections.

Int. 45. — Explain what you mean by your preceding answer with reference to some exhibit, if such there be, showing an apparatus and its connections, such as you have referred to?

A. — I mean the first single-tone transmitter, in connection with the Resonant Box Magnet Receiver, connected in circuit in the manner described in answer to interrogatory 71, on page 85, part I., "Telephone Suits," and represented in Exhibit Gray's Closed Circuit Single Tone Transmission Apparatus.

Int. 46. — When that apparatus is in condition for transmitting articulate speech, as above mentioned by you, is the key open or closed?

A. — Opened; I would add that when the apparatus was not in use, the key always stood open.

Int. 47. — How is that apparatus capable of being operated, so as to transmit articulate speech?

A. — By speaking upon the top of the box on the magnet represented by "B," in said Exhibit, currents of electricity would be induced in line "F" and through the magnet "G" and battery "C," causing the strength of the magnet "G" to vary, and producing a sound in the magnet "G" corresponding to the sound produced by the voice in speaking on the top of the box on the magnet represented by "B."

Int. 48. — State when, to your knowledge, Gray first practically transmitted articulate speech by increasing and decreasing the strength of an electric current traversing a circuit as defined in interference "A."

Adjourned until Saturday, May 8, at 10 a. m.

SATURDAY, May 8, 1880 — 10 A. M.

Same appearance as before.

A. — The first work Mr. Gray did in this direction was in the experiments and with the instrument mentioned in the answer to interrogatory 38 of this deposition, occurring during June or July, 1876.

Int. 49. — State when, to your knowledge, Gray first practiced transmitting vocal sounds, or spoken words, telegraphically, by

throwing upon the line, through the medium of a varying resistance, electric impulses corresponding to the vibrations of a diaphragm operated by the movements of the air, produced by a spoken word, as defined in "Interference B"?

A.—In June or July, 1876, with the apparatus spoken of in the preceding answer.

Int. 50.—State your first knowledge as to the construction and operation by Gray, or under his direction, of "a transmitter, consist-"ing of the combination in an electric circuit of a diaphragm and a "liquid or equivalent substance of high resistance, whereby the "vibrations of the diaphragm caused vibrations in the resistance of "the electric circuit, and consequently in the strength of current "traversing said circuit," as defined in the first count of "Interference C"?

A.—My first knowledge was from the pencil sketch Mr. Gray showed me February, 1876, as stated in my answer to interrogatory 37, of this deposition, and from the apparatus constructed in Philadelphia, in June or July, 1876, as stated in my 38th answer of this deposition.

Int. 51.—Answer the same question as to the combination in a telegraph instrument operated by sound, of a diaphragm with "two "or more electrodes placed in electrolytic liquid, and operating to "increase and decrease the resistance of the electric current by the "movement derived from the diaphragm," as defined in the second count of "Interference C"?

A.—I make the same answer as to the previous question.

Int. 52.—Answer the same question as to an Electro Hydro-Telephone, containing a fluid-holding vertically-adjustable tube, in which platinum points are immersed, as defined in "Interference D"?

A.—I make the same answer.

Int. 53.—Answer the same question as to the combination "in an "Acoustic Telegraph of an armature plate, an electro magnet for "the same, and a closed circuit passing from the helix of such mag-"net to a source of undulatory electric energy" as defined in "Interference E"?

A.—My first knowledge was from the instruments and experiments made in May, 1874, with the Resonant Box Magnet Receiver in connection with the first Single Tone Transmitter.

Int. 54.—Answer the same question as to "a telephonic transmitter consisting of a coil of wire, one or more magnets, and a disc or diaphragm so arranged relatively to each other that a motion in the diaphragm shall induce in the coil of wire an electo motive force in virtue of the presence of the magnet or magnets," as defined in the first count of "Interference F"?

A.—My first knowledge of an instrument answering this description was in May, 1874, but it was not used at that time as a transmitter. My first knowledge of its use by Mr. Gray, as a transmitter, was in January or February, 1877, this instrument being a modification of Gray's Resonant Box Magnet Receiver.

Int. 55.—Answer the same question as to "the combination in one circuit of two or more coils of wire, two or more magnets, and two or more discs or diaphragms so arranged relatively to each other, that if one of the discs or diaphragms be put in motion by the voice, by a current of air, or otherwise, it shall induce a transient current of electricity in its associated coil, which current shall actuate the other discs or diaphragms in virtue of the coils and magnets associated with them," as defined in the second count of "Interference F"?

A.—My first knowledge as to the construction and operation by Mr. Gray of this combination was in January or February, 1877. We used two instruments, such as are referred to in my last answer, being modifications of the Resonant Box Magnet Receiver.

Int. 56.—Answer the same question as to "A telephonic receiver, consisting of the combination in an electric circuit of a magnet and a diaphragm, supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality," as defined in "Interference G"?

A.—My first knowledge was from the instruments and experiments made in May, 1874, with the Resonant Box Magnet Receiver.

[*Recess.*]

Int. 57. — Answer the same question as to "A Telephonic Trans-"mitter, consisting of one or more helices forming a portion of the "main circuit, and surrounding a core or cores maintained in a mag-"netic state by the inductive influence either of an electric current, "or of a permanent magnet in combination with an elastic inductive "plate or armature, which is rigidly supported at one or more of its "edges, while the portion facing the poles of the magnetic core or "cores is left free, so as to be capable of responding to sonorous "vibrations traversing the atmosphere or other bodies," as defined in "Interference I"?

A. — My first knowledge of the construction of such an apparatus by Mr. Gray, being Gray's Resonant Box Magnet Receiver, was in May, 1874, and my first knowledge of the use of such an instrument as a transmitter, by Mr. Gray, was in January or February, 1877; I refer to the same instrument spoken of in my 54th answer.

Int. 58. — Answer the same question as to "the combination with an electro magnet of an iron or steel diaphragm secured to a reson-ant case for rendering audible acoustic vibrations," as defined in "Interference J"?

A. — My first knowledge as to the construction and operation, by Mr. Gray, of this combination, was in May, 1874, the instrument being Gray's Resonant Box Magnet Receiver.

Int. 59. — Answer the same question as to "The combination in an "acoustic telegraph of an electro magnet and a polarized armature "formed of a plate of iron or steel or other material capable of "inductive action, and a resonant tube or case," as defined in the first count of "Interference L"?

A. — My first knowledge as to the construction and operation by Mr. Gray of this combination, was in May, 1874. The operation consisted in using the Gray's Resonant Box Magnet Receiver with the resonant box touching but one pole of the magnet, the other pole being separated a little distance from the box, either being held in that position by the hands or by a little brace placed between the box and the rubber head of the magnet in a direct battery circuit, as shown in the diagram, Gray's Closed Circuit Transmission Ap-paratus.

Int. 60. — State what further knowledge you have of the construction and operation by Gray of instruments involving the organization referred to in the previous question?

A. — Gray's Wooden Sounding Box Magnet Receiver was made and used in December, 1874, also Gray's Sounding Box Receiver made and used in December, 1875, and patented April 11, 1876, patent 175,971, "Exhibit Sounding Box Receiver Patent" in these interferences (shown in the application which is on pages 651 to 654 and cut between pages 652 and 653, part II., "Telephone Suits,") when these receivers are used in direct battery circuit as stated in the last answer. Also Gray's Supplementary Magnet Telephone, made and used in the fall or winter of 1877, application for patent on the same filed January 17, 1878 — Exhibit Supplementary Magnet Telephone Application, case 4, in these interferences.

Int. 61. — State what was the first knowledge you had of the construction and operation by Gray of an apparatus involving "the "combination in an acoustic telegraph of an armature plate polar- "ized by induction, a resonant case or tube, an electro magnet and "circuit connections whereby reverse currents are caused to act in "the electro magnet with varying intensity, proportionate to the "electric waves sent from the transmitting station," as defined in the second count of "Interference L"?

Adjourned until Monday, May 10, 1880, at 11 a. m.

MONDAY, May 10, 1880, 11 a. m.

Same Appearances as before; and Mr. McDonough for himself.

A. — My answer to the 59th interrogatory will answer this question, inasmuch as the extra current caused by the reed closing and opening the short circuit consists of reverse currents.

Int 62. — State what further knowledge you have of the construction and operation by Gray of instruments involving the organization referred to in the previous question.

A.— This question is answered by my answer to the 60th interrogatory, with this addition, which should have been included in that answer; in the winter of 1874 Mr. Gray experimented with an apparatus consisting of an ordinary electro magnet mounted on a base having a thin sheet of steel supported a short distance above the poles of the magnet, at the point where it was found, by trial, to give the loudest tone. This was used in connection with a resonant glass globe open at each end placed over the plate but not touching it.

(*Wood cut of this apparatus introduced in evidence, marked Exhibit Gray's Glass Resonator.*)

And, also, Gray's Supplementary Magnet Telephone was made and used in the winter of 1877.

[*Recess.*]

Cross-examination, by Mr. Storrow:

Cross Int. 63.— The instrument referred to in your 38th answer as made in the summer of 1876, in Philadelphia, was the first instrument constructed according to Mr. Gray's directions, by which he or you had attempted to transmit articulate speech by electricity, by talking to the transmitting instrument, was it not?

A.— It was.

Cross Int. 64.— Had you ever heard from Mr. Gray any description of any instrument which he had devised for transmitting articulate speech electrically by talking to the transmitter, before the Liquid Transmitter shown in a drawing which he exhibited to you February 11, 1876, and put in evidence in the 37th answer?

A.— I heard no description from Mr. Gray of any instrument which he had devised fully, but merely some idea or plan by which it could or might be done, before the time specified.

Cross Int. 65.— When you tried the Liquid Transmitter at Philadelphia in the summer of 1876, did you and Mr. Gray succeed in transmitting an articulate sentence through it so that it was heard at the receiving end of the line?

A.— I was at the transmitting instrument, speaking into it, and did not once listen at the receiving instrument, Mr. Gray being at

the receiving instrument. I do not know with what success he received my talking.

Cross Int. 66. — Do you know whether he received it at all, as articulate speech?

A. — I do not.

Cross Int. 67. — What instrument did you use as a receiver in those experiments?

A. — I do not remember of being at the receiving end, or seeing what receiver was used.

Cross Int. 68. — When did you next attempt to transmit articulate speech with a transmitter, constructed according to Mr. Gray's caveat of February, 1876?

A. — A little later in the summer or in the fall of 1876, with the same transmitter mentioned above.

Cross Int. 69. — What did you use for a receiver on this second occasion?

A. — I do not know, Mr. Gray being at the other end of the line, in New York.

Cross Int. 70. — Look at your forty-seventh answer. If the apparatus there spoken of would operate as you indicate, it would be because the instrument which had been intended for a receiver might, when spoken to, operate like a Bell Magneto Telephonic Transmitter. Is that what you mean?

A. — That is not all I meant. The instrument which had been intended for a receiver would operate and has, when spoken to, operated like a Bell Magneto Telephone Transmitter, and the instrument then used as a transmitter would operate as a receiver.

Cross Int. 71. — You think that transmitting instrument "G," on the diagram Gray's Closed Circuit Single Tone Transmission Apparatus would operate as a receiver for articulate speech, so as to render that speech audible?

A. — I think it would.

Cross Int. 72. — Then you think that instrument "G" would act as a common receiver, capable of reproducing audibly and faithfully, sounds of different pitches?

A. — I think it would.

Cross Int 73. — Did you ever actually try to transmit articulate speech with the instruments and apparatus, and in the manner indicated in your 47th answer?

A. — I did not.

Cross Int. 74. — Then it would have been better to have said in your 44th answer, that it was your opinion that it could be so used, instead of saying "We find it can be used," etc., would it not?

A. — I think I am satisfied with that answer.

Cross Int. 75. — Every one of the instruments which Mr. Gray made or used for transmitters before the Liquid Transmitter, which was made in the summer of 1876, contained a conductor which was vibrated to and from a contact stop alternately, did it not?

A. — That is correct.

Cross Int. 76. — And in each of them an electric circuit passed through the vibrating conductor and through its contact with the contact stop when the two were in contact, was it not so?

A. — That is so.

Cross Int. 77. — And in each of them that vibrating conductor operated at each vibration to make and break that portion of the circuit which passed through those parts of the transmitter, did it not?

A. — It did.

Cross Int. 78. — And in every such transmitter the main battery furnished a current which passed through those parts of the transmitter when they made contact, did it not?

A. — This is the case with such transmitters as were used in connection with a main battery. In case of a transmitter containing primary and secondary wires — induction coil — no main battery is used. In regard to the making and breaking of contact between

the vibrator and contact point, under certain adjustments, it is probable that no break occurs, the vibrator, in this case, acting to increase and decrease the resistance of the circuit of which they form a part.

Cross Int. 79. — In the case of transmitters with which an induction coil was used, the battery whose electric energy generated the induced currents that worked the line, furnished a current which passed through the vibrator and contact point of the transmitter, did it not?

A. — It did.

Cross Int. 80. — All these transmitters were of the class of instruments commonly known as circuit-breakers or current interrupters, were they not?

A. — They were.

Cross Int. 81. — In every case the variation or vibration of the current in the main line, while the apparatus was at work, was due to this motion of the vibrator of the transmitter, and corresponded in rapidity of succession to the rate of motion of this vibrator. Is it not so?

A. — That is so.

Cross Int. 82. — And in every case the vibrational currents on the main line were due to the combined action of the battery and the vibrator of the transmitter, one of them furnishing the electric energy and the other giving the vibrational character; was it not so?

A. — The vibrational currents on the main line were due to the combined action of the battery and the vibrator of the transmitter, both furnishing electric energy, one as the battery the other as an inducer.

Cross Int. 83. — Did you construct the Liquid Transmitter at Philadelphia before or after you or Mr. Gray had seen Mr. Bell's Telephone?

A. — After.

Cross Int. 84. — Before you saw Mr. Bell's Telephone on that occasion, did you suppose that any of Mr. Gray's Magnet Receivers could be used as transmitters of articulate speech on the magneto principle?

A.— I did not. I had not thought of it.

Cross Int. 85.— You have spoken several times of having used some of Mr. Gray's transmitters in a closed circuit. I understand that by that phrase you refer to an arrangement of the circuit in which the circuit breaking transmitter is placed in a shunt circuit around a part or the whole of the principal battery, the rest of the circuit being always closed. Am I right in that?

A.— That is right.

Cross Int. 86.— Such an arrangement of circuits is shown in Boscha's Duplex, exhibited in figure 313, page 589, of Prescott's "Telephone," in which the circuit breaking keys are placed in shunt circuits around the batteries or sections of battery which shunt circuits are opened and closed by the action of the keys, without breaking the main line; is it not so?

A.— That is not so. In this case the different sections of the battery are opposed to each other, the copper of one section being connected with the copper of the other.

Cross Int. 87.— Would you call that Boscha arrangement a closed circuit in the same sense in which you have used that term in your deposition?

A.— If the line in the cut mentioned is understood to be connected directly with the ground, I should call it a closed circuit.

Cross Int. 88.— The same arrangements as Boscha's for short circuiting the battery by a circuit breaking key placed in a shunt circuit, is shown by the device known as Kramer's Key, exhibited and described in figure 493, page 830, in Prescott's book on Electricity; is it not?

A.— It is.

Cross Int. 89.— Have the instruments referred to in your 48th to 52d answers, inclusive, been produced in evidence?

A.— They have not.

Cross Int. 90.— Look at your 53d answer, and tell me what arrangement of circuit connections was used in the experiments therein referred to?

A. — The arrangement of circuit connections shown in Exhibit Gray's Closed Circuit Single Tone Transmission apparatus.

Cross Int. 91. — In that arrangement of circuits, was that part of the circuit which passed through the vibrator of the transmitter continually closed?

A. — It was not, except in the case mentioned in the last part of my answer to interrogatory 78.

Cross Int. 92. — You intended, in the use of those transmitters, at that time, to have them adjusted so that the vibrator should make a clean break, and not hang on the contact stop; did you not?

A. — They were intended to be so used.

Cross Int. 93. — Please look at your 54th answer. You mean by that, I suppose, that the instrument used in 1877, was a modification of that used in 1874?

A. — Yes, sir.

Cross Int. 94. — What do you call the diaphragm of the Resonant Box Magnet Receiver?

A. — The plate nearest the poles, generally; but both the top and bottom plates are diaphragms.

Cross Int. 95. — Which do you refer to in your 56th answer as the diaphragm?

A. — The plate nearest the poles.

Cross Int. 96. — In the exhibit produced, that plate is not supported except by resting on the poles themselves; is it?

A. — It is not.

Cross Int. 97. — In that exhibit, what part do you call the Resonant tube or case?

A. — The box of which the diaphragms form a part.

Adjourned to Tuesday, May 11, at 10 a. m.

TUESDAY, May 11, 1880, 10 a. m.

Same appearances as yesterday.

Cross-examination resumed.

Cross Int. 98. — Please to look at your 57th answer. Is there any exhibit in this case which is the instrument there referred to, or which is a duplicate of, or drawing of it? and if so point it out.

A. — There is a cut of the instrument spoken of on one of the leaves between pages 578 and 579, part II., "Telephone Suits." This drawing shows the apparatus or instrument spoken of, but not the manner of using. A duplicate of the original instrument is in evidence as an exhibit, marked Gray's Resonant Box Magnet Receiver, which was put in evidence in the telephone suits.

Cross Int. 99. — In that exhibit do you find an "elastic inductive "plate or armature which is rigidly supported at one or more of its "edges, while the portion facing the poles of the magnetic cores is "left free?"

A. — Yes; I see two such inductive plates.

Cross Int. 100. — Please point them out in the exhibit.

A. — The diaphragms at each end of the resonant box.

Cross Int. 101. — Please point out which part of the apparatus rigidly supports the diaphragm at one or more of its edges, and leaves the portion facing the poles of the magnet free?

A. — The rim or cylinder forming a portion of said box.

Cross Int. 102. — What supports the rim or cylinder?

A. — As it is exhibited, it is supported by the poles of the magnet.

Cross Int. 103. — Does the rim or cylinder touch either of the poles of the magnet as exhibited?

A. — It does not.

Cross Int. 104. — Then how is it supported by the poles of the magnet?

A. — The resonant box is constructed entirely separate from the magnets, and is placed, in the exhibit, resting upon the poles of the

magnet, as it was frequently used; other methods of using it have been described in the evidence, one of which ways was supporting the box a little distance from the poles. In the use spoken of in the answer to the 57th interrogatory, the modification of it was supported, the poles not touching the plate.

Cross Int. 105. — That exhibit, as put into the case and without the modification and support spoken of in your last answer, does not present "an elastic inductive plate or armature which is rigidly sup- "ported at one or more of its edges, while the portion facing the "poles of the magnetic core is left free," does it?

A. — It does. The upper plate or diaphragm is supported at its edges, and is free to vibrate.

Cross Int. 106. — In your 57th answer, in the first portion of which your language refers to Gray's Resonant Box Magnet Receiver, which plate did you intend that we should understand to be the inductive plate or armature specified in the 57th question?

A. — The lower plate, used as I have described heretofore, separated a little distance from the cores of the magnet. This exhibit represents the apparatus and not the manner of its use referred to in the 57th answer.

Cross Int. 107. — I ask you again whether in that exhibit there is anything that rigidly supports that lower plate at its edges, leaving the portion opposite the poles of the magnet free, and if so, point out what it is.

A. — As the exhibit now stands, the lower plate is not supported free from the poles of the magnet, as the plate was supported in its use spoken of in the 57th answer.

Cross Int. 108. — That exhibit has not been changed any since it was first put in evidence, has it?

A. — Not to my knowledge.

Cross Int. 109. — The cut referred to in your 98th answer is a part of the specification of Mr. Gray's Patent 166,095, is it not?

A. — It is.

Cross Int. 110. — The resonant box of the exhibit is represented by the part marked "S" on the lower part of sheet 1, of the drawings of that specification, is it not?

A. — It is.

Cross Int. 111. — Does that drawing show any support for the box "S," except that its lower plate rests on the poles of the magnet?

A. — It does not.

Cross Int. 112. — The only reference to that box in the text of the specification speaks of it as "a hollow cylinder S of metal placed on poles of the magnet," does it not?

A. — It does.

Cross Int. 113. — In your 58th answer, do you refer to the Gray Resonant Box Magnet Receiver, as that instrument is exhibited in the exhibit so marked in this case, and as it is shown in said patent, or do you refer to it with the addition of some means of supporting said box out of contact with the poles?

A. — I refer to it as it is exhibited, and I also refer to it as it was used, with the diaphragm supported sometimes with one pole free, sometimes with both poles free, and not touching the diaphragm.

Cross Int. 114. — What part of it did you refer to as the "diaphragm" in your said 58th answer?

A. — The lower plate.

Cross Int. 115. — Did you, in that answer, intend to refer to the lower plate as the diaphragm, when the box was supported by the lower plate resting on the poles, as exhibited?

A. — I did.

Cross Int. 116. — When the box is so supported on the poles, it is the diaphragm which supports the resonant case, and not the resonant case which supports the diaphragm, is it not?

A. — The 58th question speaks of the diaphragm as secured to a resonant case, not as supported by it. Arranged as mentioned in the preceding question, the case is supported by the diaphragm.

Cross Int. 117. — Please look at your 61st answer. The extra currents there referred to are the currents which always accompany the closing and opening of a circuit by a circuit-breaker, when a battery is included in the circuit, are they not?

A. — They are more than that. The extra currents there referred to are caused not only by closing and opening the battery current, but by the induction caused by charging and discharging the magnet. The extra currents in this latter case are very much more powerful than when a simple battery current is closed and opened.

Cross Int. 118. — The extra currents referred to in your 61st answer, then, are the well-known induction currents which always accompany the make and break of a circuit in which a battery and the coils of an electro magnet are included, are they not?

A. — They are the same, but the manner in which they work in this case is to assist in sending the vibrations or waves through the line and receiving instrument, instead of retarding, as is the case when closing and opening a battery circuit, which circuit contains a magnet as mentioned in the question.

Cross Int. 119. — I suppose your idea is, that the assisting effect which you think takes place, as stated in your last answer, is due to the fact that the vibrator is in the shunt circuit instead of the main line, is it?

A. — It is due to the fact that the magnet and the vibrator are in the shunt circuit, and that the magnet is in both circuits.

Cross Int. 120. — It is the transmitting magnet that is in both circuits and the receiving magnet is in the main circuit alone. Is it not so?

A. — It is so.

[*Recess.*]

Cross Int. 121. — Do you mean that these extra currents assist the electrical vibrations or waves which pass through the line to come more sharply and rapidly to their maximum, and to fall off more sharply and rapidly to their minimum, than they otherwise would?

A. — I do, and that they cause a more rapid and stronger magnetization of the cores of the receiving magnet, and a more rapid demagnetization of the same.

Cross Int. 122. — I understand from your testimony in the Telephone Suits, as well as from that in this deposition, that there is always some battery current flowing over the main line circuit and through the coils of the receiving electro magnet, so that the cores of the magnet never entirely lose their polarity or become entirely demagnetized. Am I correct in that?

A. — That is correct.

Cross Int. 123. — The instrument shown in the wood cut, Exhibit "Gray's Glass Resonator," referred to in your 62d answer, is intended and adapted to give forth audibly only the tone normal to it, and none other. Is it not so?

A. — It was intended to give forth the particular tone, corresponding in pitch to the enclosed air space of the glass globe, with more power than any other tone. It would receive and render audible any tone that might be sent from the transmitting instrument.

Cross Int. 124. — When was that apparatus first made?

A. — The last part of 1874.

Cross Int. 125. — Is this instrument shown in any patent which Mr. Gray has obtained, or in any application for a patent which has been put in evidence?

A. — It is not.

Cross-examination, by Mr. L. W. Serrell:

Cross Int. 126. — Please look at the diagram I now furnish you, and I ask whether or not the same is a correct representation of "Gray's Closed Circuit Single Tone Transmission Apparatus," so far as the circuit connections are concerned?

A. — It is.

(*Diagram introduced, marked "Exhibit Gray's Circuit Connections."*)

Cross Int. 127. — Please examine the patent No. 141,777, granted August 12, 1873, to T. A. Edison, and found on page 571, vol. 2, "Telephone Suits," and state when you first knew of the existence of said patent, by examining a copy of it, or otherwise, directly or indirectly, learning what it contained or any part of the contents.

A. — I learn of this patent now for the first time. I may, possibly, have heard something of it—not as being patented, but as something that had been tried by Mr. Edison. I can give no definite knowledge as to the time or place. I may have heard it spoken of.

Cross Int. 128. — Do you remember any conversation with Mr. Gray or any other person, in relation to this Edison device, at or about the time of Mr. Gray's caveat?

A. — I do not.

Cross Int. 129. — Please compare the line circuit connection, shown in this Edison Patent, No. 141,777, with the Exhibit Gray's Circuit Connections, and presume that the armature, d, and lever, f, in the said Edison patent, vibrate at the same rate as the reed in Gray's Single Tone Transmitter, and inform us what, if anything, will be the difference in the electric currents at the distant receiver, having a special reference to any reversal of the currents, as spoken of in answer to interrogatory 61 of your deposition, and to cross interrogatories 117 and 118?

A. — I think my answer to the 117th interrogatory will answer this question, substituting for "when a simple battery current is closed and opened" the words "when Edison's apparatus shown in Edison's patent mentioned in the question is used."

Cross Int. 130. — With the exception of the current being more powerful in the one case than the other, can you point out any other difference?

A. — In Mr. Gray's apparatus mentioned, the battery current is accompanied by induced or extra currents that are alternately in the direction of the battery current and in the opposite direction to the battery current. This is not the case with the Edison apparatus mentioned.

Cross Int. 131. — Do these induced or extra currents in the Gray apparatus extend to the receiving instrument or are they simply local?

A. — They extend to the receiving instrument.

Cross Int. 132. — And would those currents at the receiving instrument on a galvanometer indicate a reversal of the currents or a rise or fall in tension?

A. — I have never tried the experiment, and do not know whether the galvanometer would indicate the reversals or not.

Adjourned until Wednesday, May 12, at 10 a. m.

WEDNESDAY, May 12, 1880.

Same appearances as yesterday.

Cross-examination, by Mr. Storrow:

Cross Int. 133. — Mr. Gray's Interfering Application, Case 1, page 4, describes the magnet receiver, figure 1, as provided with a diaphragm, to which is attached a piece of soft iron, "constituting an armature, in close proximity to the core of a magnet," and provided with adjusting screws to adjust the magnet and diaphragm in proper relation to each other. His interfering application, Case 3, at the top of page 3, describes the receiver as having a magnet, "the poles of which approximate closely the diaphragm," while the relation of the poles of the magnet to the diaphragm is controlled by means of a screw. Please to tell me at what distance from the poles of the magnet the armature or diaphragm should be placed in constructing a receiver in accordance with those specifications?

A. — In constructing such receivers, I should arrange them in such a manner that the poles of the magnet and the armature or diaphragm could be placed in contact with each other, or separated from an eighth to a quarter of an inch. Adjusting them for use, I should bring them as near together as I could, so that while vibrating they would not touch each other. Then I would listen at the receiver, while some other person was talking through the transmitter,

the two connected in circuit, as shown in said application, and adjust forward or back, until I should get the best results.

Cross Int. 134. — What leads you to specify the distance of "an eighth to a quarter of an inch"?

A. — I would do it simply to give it plenty of room for adjustment.

Cross Int. 135. — In the construction of electrical apparatus generally, at what distance from the armature to be moved is it customary to place the poles of the electro magnet variations in whose magnetism are to move the armature?

A. — Electrical instruments generally, that are adjustable in relation to the poles and armature, are constructed so that the poles of the magnet and armature can be separated a quarter of an inch or brought together.

Cross Int. 136. — Why is it not desired to place the armature further than a quarter of an inch — say an inch?

A. — It is desirable sometimes to give an adjustment of more than a quarter of an inch. I do not recall any instruments with an adjustment of an inch, but presume there are such.

Cross Int. 137. — How near the poles of the magnet should the diaphragm of the receiver of a speaking telephone be placed, in order that such diaphragm may have any sensible effect in the production of sound audible to the human ear as articulate speech?

A. — It may touch the poles or it may be removed from them. The distance between them when the diaphragm ceases to produce a sensible effect audible to the human ear as articulate speech I cannot give.

Cross Int. 138. — In the Exhibit Gray's Glass Resonator, what, if anything, serves to magnetize or polarize the armature plate. Please look at your 62d answer?

A. — The electro magnet, which is placed immediately under the armature.

Cross Int 139. — Is that armature polarized by any means except by being placed in proximity to, but without touching the poles of

the electro magnet, the variations in whose magnetism operate to give the armature its desired motion?

A. — It is not.

Cross Int. 140. — Is not every soft iron armature which is placed so as to be moved by the variations in magnetism of an electro magnet — as, for example, in the case of an ordinary Morse Relay — polarized in the same sense and by the same means as those referred to in the last question?

A. — They are, but not to the same extent. The soft iron armature mentioned would lose its magnetism immediately on being removed from the poles of the electro magnet, or by the opening of the battery current charging such electro magnet. A steel armature, under the same conditions, would retain its magnetism for a long time.

Cross Int. 141. — I suppose that even a soft iron armature would retain some polarity as long as the cores of the electro magnet retain any, by reason of their magnetic inertia or residual magnetism, would it not?

A. — I think it would.

Cross Int. 142. — If the polarity of the cores were reversed by a reverse current, I suppose that the polarity induced in the armature in the case of an ordinary Morse Relay and in the case of the glass Resonator Exhibit, would not be maintained, but would be reversed, in the case both of the steel armature and the soft iron armature, would it not?

A. — It would.

Cross Int. 143. — Section 62, on page 59 of Preece & Sivewright's book on Telegraphy, describes an ordinary Morse Relay, does it not?

A. — Yes, it does.

[*Recess.*]

Cross Int. 144. — The next section in Preece and Sivewright, viz., section 63, is as follows: "There are many different forms of relays. "Such a one as that just indicated is called a *non-palarized* relay, but "it is not much used in England. The forms of relay more largely

"used are called *polarized*, because their armatures are either perma-"nent magnets or are maintained in a magnetized condition by per-"manent magnets. They differ principally from the non-polarized "because they are affected by the direction of the current, and under "certain circumstances they are far more sensitive." Does or does not that statement conform to the ordinary use of the words *polarized* and *non-polarized* among electricians, as applied to armatures?

A. — I think it does, although I do not remember having heard the ordinary Morse relay called non-polarized before.

Cross Int. 145. — Why was the armature of Gray's Glass Resonator made of steel?

A. — Mr. Gray used armatures of iron and also of steel. Why he preferred the steel I do not know.

Cross Int. 146. — Mr. Gray's interfering application, Case 4, shows a diaphragm polarized by induction, by being placed in magnetic and metallic connection with an electro magnet which was kept constantly polarized by a special local battery and current, does it not?

A. — It does.

W. M. GOODRIDGE.

DEPOSITION OF ELISHA GRAY.

ELISHA GRAY, being duly sworn, doth depose and say, in answer to interrogatories propounded to him by W. D. BALDWIN, as follows:

Int. 1. — Are you the Elisha Gray who is a party to these interferences?

A. — I am.

Int. 2. — Are you the Elisha Gray who testified in behalf of the defendant in the "Telephone Suits" of *The Bell Telephone Co.* v. *Dowd*, and are all the statements contained in your two depositions in that case true?

A. — I am the same, and the statements are all true, to the best of my knowledge.

Int. 3.— Have you read or heard the deposition of William M. Goodridge, given in these interferences?

A.— I have.

Int. 4.— State briefly the facts relative to the conception and development of your invention for the transmission of musical sounds during the early part of the year 1874, prior to the employment of Goodridge as your assistant?

A.— The first work I did in this direction, in the year 1874, was in the latter part of January, or early in February. Having returned from my day's work, I happened to go into the bath-room, and there found my nephew playing with a small induction coil. In explanation of the circumstance referred to, I quote from a paper read by me before the American Electrical Society, March 17, 1875:

"He was, as he expressed it, taking shocks for the amusement of "the smaller children. He had connected one end of the secondary "coil to the zinc lining of the bath tub, which was dry at that time. "Holding the other end of the coil in his left hand, he touched the lin- "ing of the tub with his right. In making contact his hand would "glide along the side for a short distance. At these times I noticed "a sound proceeding from under his hand at the point of contact, "which seemed to have the same pitch and quality as that of the vi- "brating electrotome, which was within hearing. I immediately took "the electrode in my hand, and, repeating the operation, to my aston- "ishment found that by rubbing hard and rapidly I could make a "much louder sound than the electrotome was making. I then changed "the pitch of the vibration, increasing its rapidity, and found that the "pitch of the sound under my hand was also changed, it still agree- "ing with that of the vibration. I then moistened my hand and "continued the rubbing, but no sound was produced so long so my "hand remained wet; but as soon as the parts in contact became dry "the sound reappeared." So striking was the effect, that by hard "rubbing with the dry hand the noise could be distinctly heard "throughout the house.

The arrangement of circuits used in the above described experiment is shown in the book entitled "The Speaking Telephone, the

Electric Light and other Recent Electrical Inventions," by Prescott, in figure 84, page 187, in the edition of 1879.

(*Wood cut offered in evidence, marked Exhibit Bath Tub Experiment.*)

During the month of February, 1874, I experimented at the house with various receiving instruments, using the same transmitter. Prominent among these receivers was the one designated Animal Tissue Violin Receiver. Experiments were made with this and receivers of a similar character during this month and the month of March, 1874, which brings us to the time of the employment of Mr. Goodridge, about the 1st of April. During this period I conceived the idea of transmitting musical compositions and sounds of all kinds, including articulate speech.

During this time I conceived the idea of making a key-board transmitter for transmitting musical compositions, the first one of which was completed in May, 1874.

Int. 5. — How far did your conception of the idea of transmitting articulate speech extend at this time?

A. — During these experiments, I observed that the quality of the sound made by the transmitter was faithfully reproduced in the receiver. This led me to the conclusion that it was only a question how to convert the aerial vibrations made by the production of any sound whatever into electrical vibrations of a similar character, with respect to rate, amplitude, etc., to solve the problem of transmitting articulate speech. I was convinced that the receiver would reproduce articulate words, inasmuch as it seemed to be capable of reproducing any form of vibration that I was able to transmit. I remember speaking of this to different ones about this time. I may have mentioned this before the first of April, or it may have been a little while after. My impression is that I first mentioned it before. My conception then of an instrument for transmitting articulate speech was one of a complicated character, having a series of transmitting points adapted to respond to all the tones of the human voice, somewhat similar to the apparatus referred to in my caveat of February

14, 1876, and explained in my answer to cross interrogatory 96, page 135, part I., "Telephone Suits."

Int. 6. — What have you to say as to the correctness of the statements in Goodridge's answers 5, 6, 7, 8, 11, 12, 13 and 22, as to transmitters constructed prior to August, 1874?

A. — The statements are correct.

Int. 7. — Have you read the various issues in these interferences as defined in the official letter of March 26, 1878, and do you understand the same?

A. — I have read the official letter, and I believe I understand the issues.

Int. 8. — State when you first conceived and when you first practiced "the art of transmitting and reproducing sonorous waves or "vibrations of any description, which consists in increasing and de- "creasing the strength of an electric current traversing a circuit in "such a manner as to produce in said circuit a series of electrical "waves or vibrations precisely corresponding in their intervals of "succession and relative amplitudes to the sonorous waves which are "to be reproduced at the receiving station or stations," and specify the apparatus with which you so practiced said art.

A. — This question is answered by Mr. Goodridge's answers to interrogatories 42 and 43, this case, which answers are correct.

Int. 9. — Were any of the apparatuses referred to in Goodridge's 43d answer adapted for the transmission of articulate speech?

A. — The Single Tone Transmission apparatus could have been so used if we had used the receiver as a transmitter, and the transmitter as a receiver, without any change in the circuit connections in reference to battery and instruments, although we were not aware at that time that we could use this receiver as a transmitter. We were aware, however, that the receiver was capable of reproducing any sound that could be transmitted.

Int. 10. — What do you say as to the correctness of Goodridge's answers 44, 45, 46 and 47 as to this apparatus?

A. — Those answers are correct.

Adjourned until Thursday, May 13, at 9:30 a. m.

THURSDAY, May 13, 1880 — 9:30 a. m.

Same appearances as yesterday.

Int. 11. — State what knowledge you have as to the capacity of the core of a permanent or electro magnet for audibly reproducing articulate speech?

A. — I have tried the experiment of receiving rhythmical vibrations representing composite tones, musical compositions or articulate speech upon an electro magnet, without either diaphragm or armature of any description. The results I obtained in all these respects were entirely satisfactory. For instance, on the 11th of this month, I put in the place of the ordinary telephonic receiver, at the end of a line terminating in my house, a small electro magnet, having neither diaphragm nor armature of any description. I then called up Mr. Goodridge, at the other end of the line, about a third of a mile away, and told him to ask me a question. At the same time I placed the small magnet, before described, to my ear, and I heard the words, "What train are you going down on in the morning?" and I answered him immediately, "At eight o'clock." We were both using the carbon transmitter, and at my end of the line there was no other instrument on as a receiver, except the small magnet in question. I have observed the fact that an armature or diaphragm is unnecessary with an electro magnet as a receiver of vibrations, as far back as 1874. I frequently heard tunes reproduced in this way with sufficient loudness to be heard throughout a large audience room. My experience is, that the loudness of the tones reproduced, whether musical compositions or articulate speech, is very much increased by the addition of a diaphragm or armature. In case of any single tone, it is further increased by the employment of a suitable resonator. It is also my experience that the susceptibility of a receiving magnet to respond to all kinds of tones or sounds is very much increased by keeping the cores in a constant state of polarization. It is immaterial whether this polarization be obtained from contact *with* or proximity *to* what is commonly termed a permanent magnet made of steel; or whether obtained from a secondary electro magnet constantly charged from a battery; or whether obtained from a battery

inserted in the circuit of the primary magnet itself. Other things being equal, the results are the same in each of the cases mentioned.

Int. 12.—State when you first conceived and first practiced the art of transmitting articulate speech by increasing and decreasing the strength of an electric current traversing a circuit, as defined in "Interference A"?

A.—I first conceived the idea of transmitting articulate speech by increasing and decreasing the strength of an electric current traversing a circuit in the summer or fall of 1875. A description of experiments made at that time, which led to the conception of such an apparatus, will be found in my deposition, "Telephone Suits," answers to interrogatories 47 and 48, beginning on page 123, second paragraph of answer to interrogatory 47, where it refers to experiments made with Gray's Mechanical Transmitter. I conceived the idea of the Liquid Transmitter, which comes under the head of the variable resistance transmitter, and is described in my caveat of February 14, 1876, late in the fall of 1875, an account of which will be found in answer to interrogatory 49, my deposition, "Telephone Suits." I first constructed a Liquid Transmitter, such as described in my caveat, June or July, 1876. I experimented with this in the Centennial Building, in connection with the Wooden Sounding Box Magnet Receiver. The results were not satisfactory, owing, as I believe, to the fact that the receiver that I used was not adapted for reproducing vibrations of such feeble character as are transmitted by the aerial vibrations of the human voice. If I had had with me the Magnet Receiver in either of these forms, viz., the Concave Metallic Diaphragm Magnet Receiver, the Diaphragm Box Magnet Receiver, or the Resonant Box Magnet Receiver, I believe the experiment would have been a success.

Int. 13.—State when you first conceived and first practiced the art of transmitting vocal sounds or spoken words, telegraphically, by throwing upon the line, through the medium of a varying resistance, electric impulses corresponding to the vibrations of a diaphragm operated by the movements of the air, caused by a spoken word, as defined in "Interference B"?

A.— The answer to this question is contained in my last answer.

Int. 14.— State when you first conceived the invention of the Liquid Transmitter, embodying the organization specified in the first count of "Interference C," and when you first constructed and used the same?

A.— My answer to this question is contained in the answer to interrogatory 12, above referred to.

Int. 15.— Answer the same question as to the Liquid Transmitter, as defined in the second count of "Interference C"?

A.— Answer same as the last.

Int. 16.— Answer the same question as to the subject matter of "Interference D"?

A.— I make the same answer.

Int. 17.— State when you first conceived the invention of the subject matter of "Interference E," and when you constructed and used an apparatus such as is therein specified?

A.— In May, 1874, in connection with the Resonant Box Magnet Receiver and Single Tone Transmitter. This invention has been used by me from time to time, in various forms, ever since that date.

Int. 18.— Answer the same question as to the subject matter of the first count of "Interference F"?

A.— I first conceived and constructed an apparatus such as defined in the first count of "Interference F," in May, 1874, but did not use it as a transmitter at that time. Its use as a transmitter is set forth in the depositions of Mr. Goodridge and others in the "Telephone Suits." The apparatus I refer to is called the Resonant Box Magnet Receiver.

Int. 19.— Answer the same question with reference to the second count of "Interference F"?

A.— I cannot say that I ever conceived precisely the combination set forth in this count before having seen it described. The nearest approximation to this combination is shown in my Single Tone Transmission apparatus of May, 1874. By substituting a disc or diaphragm for the reed on one of the magnets in that circuit we would have the combination described in this count.

[*Recess.*]

Int. 20. — Answer the same question as to the issue in "Interference G"?

A. — I conceived the apparatus described in this count and reduced the same to practice as early as May, 1874. The instrument then used was the one known as the Resonant Box Magnet Receiver. I used another form of this apparatus, known as the Concave Metallic Diaphragm Receiver, in June or July of the same year, and in the winter following the receiver designated as the Diaphragm Box Magnet Receiver. I also used the apparatus designated as Gray's Glass Resonator about December, 1874, as near as I can recollect it.

Int. 21. — Answer the same question as to the issue in "Interference I"?

A. — I conceived and constructed an apparatus such as described in "Interference I" in May, 1874, being the Resonant Box Magnet Receiver, and first used similar apparatus as a transmitter about the winter of 1876 and 1877.

Int. 22. — Answer the same question as to the issue in "Interference J"?

A. — I conceived and constructed in May, 1874, the instrument designated as Gray's Resonant Box Magnet Receiver, which instrument answers to the description given in this count.

Int. 23. — Answer the same question as to the first count of "Interference L"?

A. — I conceived and constructed an apparatus in May, 1874, answering to the first count in "Interference L," and other apparatus made from time to time during that year and the following. Dates of construction and manner of use have been given by Mr. Goodridge in his deposition. In referring to Mr. Goodridge's answer to the 60th interrogatory, I notice that he omits to mention the Concave Metallic Diaphragm Magnet Receiver as an instrument covered by this count. I should place it in the same category with the others already mentioned by him.

Int. 24. — Answer the same question as to the second count of "Interference L"?

A. — I conceived the apparatus defined in this count in May, 1874, and constructed and used it during the same month. The instrument is designated as the Resonant Box Magnet Receiver.

Int. 25. — Examine the pencil sketch now shown you and state what it is and when it was made?

(*Sketch marked "Exhibit Gray's Speaking Telephone Caveat, original sketch," handed to witness.*)

A. — It was a rough sketch of the drawings used in my caveat of February 14, 1876. It was made the 11th of February, 1876, by me.

Cross-examination by Mr. L. W. Serrell:

Cross Int. 26. — Please state when you first became aware that in a telegraph a closed circuit had been made use of, and the message resulted from the rise and fall of electric tension in that circuit?

A. — I am unable to fix the date at this time, but the idea broadly had been a familiar one with me, I should say at least ten years.

Cross Int. 27. — About what time was it when you first became aware of the existence of Edison's patent 141,777, or of any telegraph instrument corresponding generally thereto?

A. — I cannot fix the date definitely, but should say that it was less than one year ago that I saw the cut (referring to cut at page 571, part II., "Telephone Suits"), with the specification attached thereto, in the office of Mr. Frank L. Pope, in the Western Union Building, New York City.

Cross Int. 28. — Did you or not know of the existence of a telegraph apparatus or invention corresponding generally to the said Edison patent, as early as January, 1876?

A. — I did not. I knew generally, and from experiments that I had made myself, long before that, that messages could be sent by increment and decrement of current without absolutely opening the circuit. As far back as 1867–8, I used to work a telegraph instrument by raising and lowering the platinum strip in a Grove Element, thus increasing and diminishing the electric current flowing through the circuit. The Western Electric Manufacturing Com-

pany, I should say as far back as 1871 or '2, used to manufacture what was called a water rheostat, which would produce a rise and fall in the tension of an electric current by sliding a metal rod, by hand, in or out of the liquid. I have also worked an instrument, experimentally, at least ten years ago, by shunting in and out a resistance coil included in the circuit; but I had no knowledge of Edison's application of this principle earlier than I have before stated.

Cross Int. 29. — Do you know of any instance earlier than the said Edison patent, where a telegraph instrument was constructed and used, in which the rise and fall of tension was obtained by motion given to one of the electrodes in a liquid?

A. — I don't recall any instance of the exact arrangement shown in the Edison patent referred to, although the principle involved in it was old in the art long before the date of that patent, and the fact that messages could be transmitted by such a method as shown in this patent was an obvious thing.

Cross Int. 30. — Bearing in mind the said Edison patent and your caveat of February 14, 1876, and your answer to the 11th interrogatory, in which you admit substantially that a receiver will work without a diaphragm, I ask what device is wanting in the said Edison patent to make an apparatus corresponding substantially in construction and operation to your caveat?

A. — In order to make a working apparatus capable of transmitting and receiving articulate words, it would be necessary to detach the armature lever marked "*d*" in the transmitting apparatus, and its lever, "*f*," from the movable point or screw, "*l*," which dips in the circuit cup, "*g*," containing liquid. Then it would be necessary to suspend the screw or movable point, "*l*," to the centre of a diaphragm capable of responding to all the aerial vibrations made by the utterance of a word. This diaphragm should be mounted in the usual way, and the point, "*l*," bear the proper relation to the point, "*i*," in the bottom of the cup. Now connect the line wire which in the drawing is connected to the lever, "*d*," and screw point, "*l*," to the diaphragm which is in metallic connection with the point, "*l*." With this change the apparatus would transmit articulate

speech. The receiver, in order to receive accurately the spoken words, should be divested of its armature, "*u*."

Cross Int. 31. — Suppose that a diaphragm be applied at the other end of the lever "*f*," and the spring "*e*," be adjusted so as to balance the parts, is there any reason why the apparatus shown in the Edison patent, with this addition, would not transmit articulate speech?

A. — If the lever "*f*," and the armature "*d*," were made very light, so that there would be comparatively little inertia to overcome, it is possible that with a suitable diaphragm, something approximating articulate speech could be obtained. As the armatures are ordinarily constructed, it would be next to impossible to get any satisfactory result. Made in any way, the armature and its lever would be a hindrance to its operation as a transmitter of articulate speech.

Cross Int. 32. — About when did you first become aware of the fact that a diaphragm had been used in connection with an electric circuit in the transmission of sound electrically. I refer especially to Reis's Transmitter?

A. — I saw a cut of the Reis Transmitter some time previous to 1874, but I had forgotten, if I ever knew, just what was accomplished by that apparatus, except in a very indistinct way, till it was brought to my recollection after having my attention called to it subsequent to the beginning of my investigations of the subject of transmitting sounds telegraphically.

Cross Int. 33. — Were there any one or more circumstances that led you to represent in your caveat a diaphragm and a water vessel containing the electrode?

A. — The question is answered by reference to that part of my deposition in "Telephone Suits," included between pages 122 and 125. I will make the additional statement that just previous to the time I first saw the "Lovers' Telegraph," now so-called, I had been experimenting with diaphragms of animal membrane in connection with a certain class of receivers; and during these experiments I used several small drums, attaching the center of the drum-head to

what I called a "rattler," designed to operate a local circuit. In experimenting with these drum-heads, I observed that they were very sensitive to noises made in the room from any source.

These experiments were a stepping stone which helped to lead my mind in the direction it took when I afterwards saw the "Lovers' Telegraph." The observation in respect to the Lovers' Telegraph proved to my mind that the movements of any single point in the diaphragm corresponded accurately with the movements of the air produced by any spoken word or sound. This was proved by the fact that spoken words were accurately transmitted longitudinally through a fine thread suspended to the center of the diaphragm. It immediately occurred to me that if I should substitute for the thread a fine wire for a few inches of the distance, and allow this wire to vibrate longitudinally in close proximity to another conductor, and both immersed in some fluid of high resistance, and that if this whole combination should be placed in an electric circuit, that the electric energy traversing the circuit, molded into waves or motions corresponding relatively in respect to rate, amplitude, etc., to those given to the diaphragm by the utterance of a word or other sound, that this electrical motion would be reconverted into a mechanical motion of a similar character in a suitable receiver, which, like the transmitting diaphragm, was capable of taking up and responding to all kinds of sounds.

Cross-examination by Mr. Storrow:

Cross Int. 34. — You say you have read, or heard read, Mr. Goodridge's deposition on these interferences. Are the statements contained in it true, so far as your knowledge extends?

A. — So far as I have observed, the statements are true. There may be inaccuracies which I have overlooked.

Cross Int. 35. — Please tell me the resistance of the various parts and instruments shown in "Exhibit Gray's Closed Circuit Single Tone Transmission Apparatus?"

A. — My recollection is that the receiver, B, was ordinarily made with about fifty ohms. This was much higher than necessary for experimenting in a laboratory, but was made partly with reference to

long-line use. The magnet of the transmitter in the first instruments ranged from twelve to twenty-five ohms. I should say the battery that we used ordinarily would average about three ohms to the cell. We used batteries of various sizes.

Cross Int. 36. — What would be the resistance from the point "*G*," just above the transmitting magnet through the core, the reed, the contact point, to the zinc of the battery?

A. — If the key was closed and the point in steady contact with the vibrator, the resistance would be a very small fraction of an ohm as ordinarily constructed. The resistance will depend upon the quality and length of the wire used in the shunt circuit. If the vibrator is in motion, the resistance will be greatly increased.

Cross Int. 37. — Have you ever actually transmitted articulate speech with the two instruments and apparatus arranged and used as stated in the first part of your answer?

A. — Not with those identical instruments.

Cross Int. 38. — In the arrangement and with the apparatus referred to in your 17th answer, some part of the circuit passed through the vibrating reed and contact point of the transmitter, did it not?

A. — When in operation, it did.

Cross Int. 39. — And when in operation was that part of the circuit always closed?

A. — When the transmitting vibrator was in operation, that part of the circuit was broken at each vibration, but the current was not necessarily suspended wholly.

Cross Int. 40. — Did the current then pass through that part of the circuit, or did it merely pass through the main circuit without going through the reed placed in the shunt?

A. — When the reed moved forward and separated itself from the contact point, the current was either wholly or partially suspended through that branch of the circuit. This would force the current to pass over the line through the receiving magnet into the ground. If the vibration was of small amplitude, the separation

between the reed and the point would be so slight that a voltaic arc would form between the two, and thus prevent the flow of current from entirely suspending, although it would introduce at that point a higher resistance. The relative amount of current that would flow through the shunt and over the line at this time would depend upon the amount of resistance interposed by the break in the circuit. The current would divide at the point where the shunt circuit connects with the main line, according to the well known Ohm's law.

Cross Int. 41. — When did you first think that the apparatus referred to in your 18th answer could be used as a transmitter for articulate speech?

A. — It did not occur to me to use this form of transmitter till after it had been described by Professor Bell. I was working in the direction of a transmitter using a variable resistance. It occurred to me as soon as I understood the operation of Professor Bell's instrument.

Cross Int. 42. — In the "Wash Basin Receiver," referred to in the last part of your 23d answer, what part do you call the resonant box or case?

A. — The whole cavity of the basin.

Cross Int. 43. — When did you first make and use a receiver constructed in accordance with the drawing of your caveat of February 14, 1876?

A. — About February, 1877, I constructed a receiver made of a snare drum with an iron armature glued on its center, an electro magnet mounted a short distance from the armature on a frame fastened to the walls of the drum. I made another in exact accordance with the caveat receiver, with the exception that it had a metallic diaphragm instead of the animal membane, in the fall of 1877. This is the model filed in one of the interfering cases. Another receiver was made in exact accordance with the caveat, having an animal membrane diaphragm in the winter of 1878–9.

Cross Int. 44. — Please to describe the magnet referred to in your 11th answer.

A. — I used at different times magnets of various dimensions and resistances. The one I referred to in my 11th answer, as having experimented with on the 11th inst., was a small straight bar magnet from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch long, the core was about $\frac{1}{4}$ to $\frac{3}{8}$ of an inch in diameter, and I should judge from the size of the wire that the resistance might have been anywhere from 15 to 30 ohms. The magnet was polarized when used, by placing it in contact with a permanent magnet.

Cross Int. 45. — In February, 1876, an interference was declared between you and Mr. Bell, on harmonic telegraphs, was it not?

A. — Yes.

Cross Int. 46. — It was in that interference that Mr. Bell made a preliminary statement, an extract from which is printed on page 105, part II., "Telephone Suits," was it not?

A. — I believe this to be a part of the preliminary statement referred to.

Cross Int. 47. — You attended the taking of Mr. Bell's deposition in that interference at Washington, in January, 1877, did you not?

A. — Yes.

Adjourned till Friday, May 14, 9.30 a. m.

ELISHA GRAY.

FRIDAY, May 14, 1880 — 9:30 a. m.

Same appearances as yesterday.

DEPOSITION OF MILO G. KELLOGG, a witness produced, sworn and examined on behalf of Elisha Gray, by Mr. Baldwin:

Int. 1. — Are you the same Mr. Kellogg who testified in behalf of defendant in the "Telephone Suits," and are all the statements made by you in that deposition true?

A. — I am, and they are true.

MILO G. KELLOGG.

THE DEPOSITION OF ANSON STAGER, a witness produced, sworn and examined on behalf of Elisha Gray by Mr. Baldwin:

Int. 1. — Are you the same General Stager who testified on behalf of the defendant in the "Telephone Suits," and are all the statements made by you in that deposition true?

A. — I am the same person and the statements are true.

ANSON STAGER.

DEPOSITION OF ENOS M. BARTON, a witness produced, sworn and examined on behalf of Elisha Gray, by Mr. Baldwin:

Int. 1. — Are you the same Mr. Barton who testified in behalf of the defendant in the "Telephone Suits," and are all the statements made by you in that deposition true?

A. — Yes; I am the person and the statements are true.

Cross-examination, by Mr. Storrow:

Cross Int. 2. — Will you look at 25th to 31st answers, inclusive, in General Stager's deposition, on page 189, "Telephone Suits," and state whether the answers therein contained are substantially correct?

A. — Yes, sir; those statements are correct. I was Secretary of the company at the time referred to in them.

ENOS M. BARTON.

Commission closed here.

E. H. BEEBE, *Notary.*

IN THE

UNITED STATES PATENT OFFICE.

NOTICE.

In the matter of the General Speaking Telephone Interferences A, B, C, D, E, F, G, I, J and L, declared March 26, 1878, May 27, 1879, and January 21, 1880, between

Letters patent to A. G. Bell, granted respectively March 7, 1876, as No. 174,465, and January 30, 1877, as No. 186,787; and the respective applications of

E. Berliner, filed June 4, 1877.
A. E. Dolbear, filed October 31, 1877.
T. A. Edison, Case 130, filed April 27, 1877.
" " " 144, " September 5, 1877.
" " " 145, " December 13, 1877.
" " " 148, " December 24, 1877.
Elisha Gray, " 1, " October 29, 1877.
" " " 2, " " " "
" " " 3, " " " "
" " " 4, " January 17, 1878.
J. W. McDonough, " April 10, 1876.
Geo. B. Richmond, " August 24, 1877.
Wm. L. Voelker, " May 19, 1879.

WASHINGTON, D. C., April 27, 1880.

Take notice, that on Wednesday, May 5, 1880, commencing at 10 o'clock a. m., and continuing by adjournment from day to day until completed, testimony will be taken and witnesses will be examined, in behalf of said Elisha Gray, before competent legal authority, at the Clifton House, Chicago, Illinois, when and where you may attend and cross-examine, if you see fit.

The names and residences of the witnesses to be examined under this notice are as follows:

Elisha Gray, Mrs. Elisha Gray, William M. Goodridge, and William A. Shepard, all of Highland Park, Illinois.

Enos M. Barton, Milo G. Kellogg, Anson Stager, P. Roberts, F. W. Jones, and M. C. Gridley, all of Chicago, Illinois.

Charles H. Haskins, of Milwaukee, Wisconsin; and J. E. Fenn, of Buffalo, New York; and perhaps others.

BALDWIN, HOPKINS & PEYTON,
Attorneys for Gray.

[Notices as above were duly served on—

A. Pollok and J. J. Storrow, for Bell, Berliner & Bell Telephone Co.;
F. L. Pope, for Dolbear;
L. W. Serrell, for Edison;
Gridley & Co., for McDonough;
G. W. Dyer, for Richmond;
G. W. Dyer, for Voelker;
as appears by the original notices and proof of service on file.]

STATE OF ILLINOIS, } ss.
COUNTY OF LAKE. }

At Chicago, in said State of Illinois, on the 14th day of May, A. D. 1880, before me personally appeared the above named William M. Goodridge, Elisha Gray, Milo G. Kellogg, Enos M. Barton and Anson Stager, and made oath that the foregoing depositions by them signed contain the truth, the whole truth, and nothing but the truth. The said depositions are taken at the request of Elisha Gray, at the time and place named in the notices hereto attached, to be used upon the hearing of the Speaking Telephone Interferences between Gray, Bell, Berliner, Dolbear, Edison, McDonough, Richmond and Voelker, before the Commissioner of Patents. The said parties were duly notified, as appears by the original notices hereto annexed.

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The said Bell and Berliner appeared by their counsel, J. J. Storrow, Esq.; the said Edison by his counsel, L. W. Serrell, Esq.; and the said McDonough appeared in person.

And I, the said Edward H. Beebe, reduced the said depositions of said witnesses respectively to writing; and each of said witnesses was duly sworn by me to tell the truth, the whole truth, and nothing but the truth, before the commencement of his testimony. The taking of such depositions was begun at the Clifton House, in Chicago, on Wednesday, the 5th day of May, A. D. 1880, at 10 a. m., and continued by adjournment from day to day until completed.

I further certify that I am not connected by blood or marriage with either or any of the parties interested.

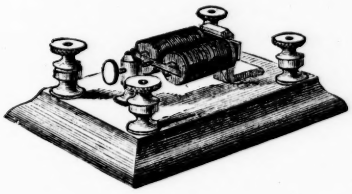
In witness whereof I have hereby set my hand and notarial seal this 14th day of May, A. D. 1880.

EDWARD H. BEEBE,
Notary Public.

[L. S.]

405

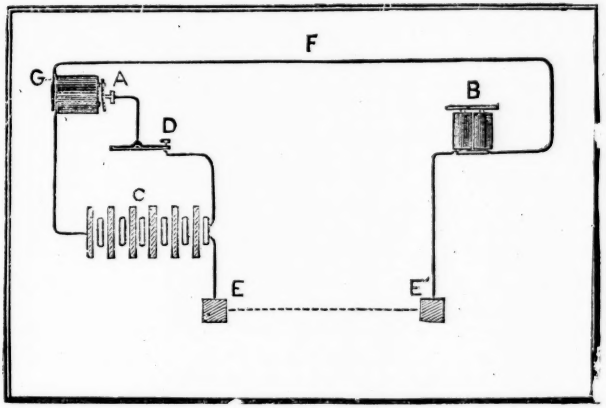
EXHIBIT, GRAY'S FIRST SINGLE TONE TRANSMITTER.



DIMENSIONS.

Length of spool,	$1\frac{1}{2}$ inches.
Diameter of spool,	$\frac{3}{4}$ "
Length of core,	$1\frac{7}{8}$ "
Diameter of core,	$\frac{1}{4}$ "

EXHIBIT, GRAY'S CLOSED CIRCUIT SINGLE TONE TRANSMISSION APPARATUS.



A Single Tone Transmitter.

B Magnet Receiver.

C Battery.

D Key in Short Circuit.

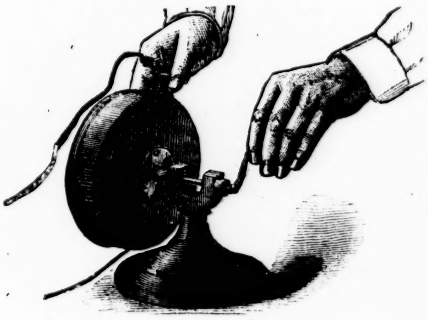
E E′ Ground Connection.

F Line Wire.

EXHIBIT, GRAY'S ANIMAL TISSUE VIOLIN RECEIVER.

4-8

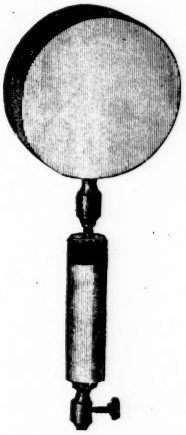
EXHIBIT, GRAY'S ANIMAL TISSUE REVOLVING PLATE RECEIVER.



DIMENSIONS.

Diameter of drum, ...	$7\frac{1}{4}$ inches.
Thickness of drum, ...	$2\frac{3}{8}$ "

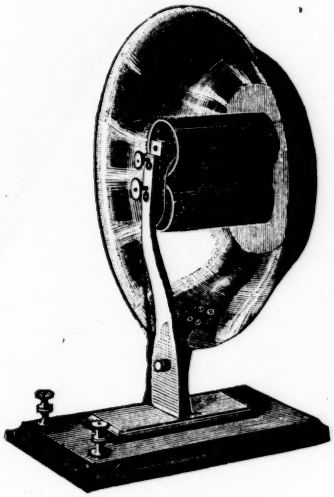
EXHIBIT, PAPER DRUM RECEIVER.



DIMENSIONS.

Diameter of drum, ...	$3\frac{3}{8}$ inches.
Thickness of drum, ...	1 "

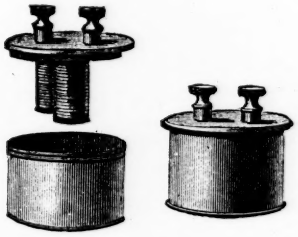
EXHIBIT, GRAY'S CONCAVE METALLIC DIAPHRAGM MAGNET RECEIVER.



DIMENSIONS.

Diameter of concave diaphragm,	11 inches.
Diameter of base of diaphragm,	$5\frac{3}{4}$ "
Diameter of spool,	$1\frac{3}{4}$ "
Diameter of core,	$\frac{3}{8}$ "
Length of core,	$3\frac{3}{8}$ "

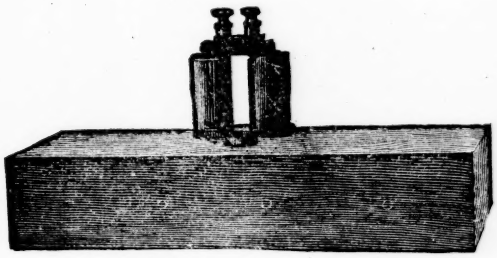
EXHIBIT, DIAPHRAGM BOX MAGNET RECEIVER.



DIMENSIONS.

Length of core,	$1\frac{1}{2}$ inches.
Diameter of core,	$\frac{1}{4}$ "
Diameter of cup,	3 "
Height of cup,	$2\frac{1}{8}$ "

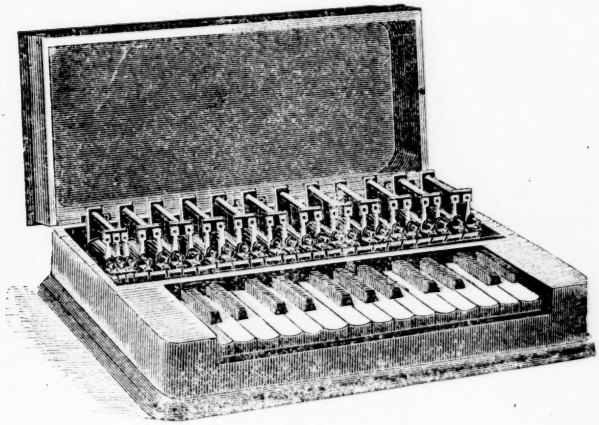
EXHIBIT, GRAY'S WOODEN SOUNDING BOX MAGNET RECEIVER.



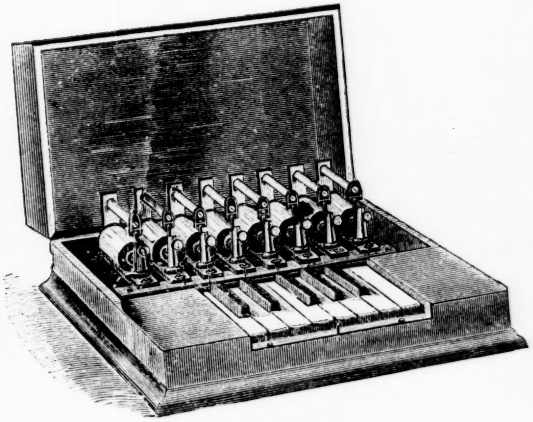
DIMENSIONS.

Length of box,	$16\frac{1}{4}$ inches.
Length of spool,	$2\frac{1}{2}$ "
Diameter of spool,	$1\frac{1}{4}$ "

EXHIBIT, GRAY'S TWO OCTAVE TRANSMITTER.



EXHIBIT, GRAY'S ONE OCTAVE TRANSMITTER.



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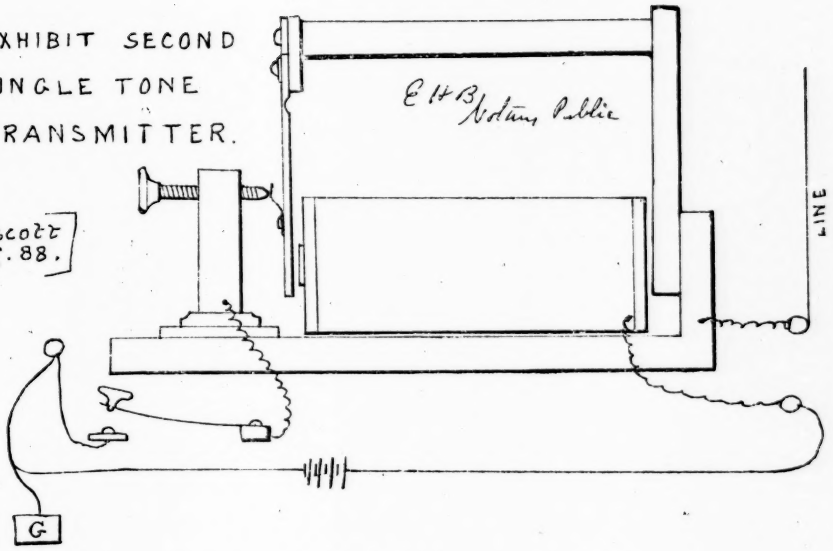
E H & B
Notary Public

EXHIBIT SECOND
SINGLE TONE
TRANSMITTER.

E H & B Notary Public

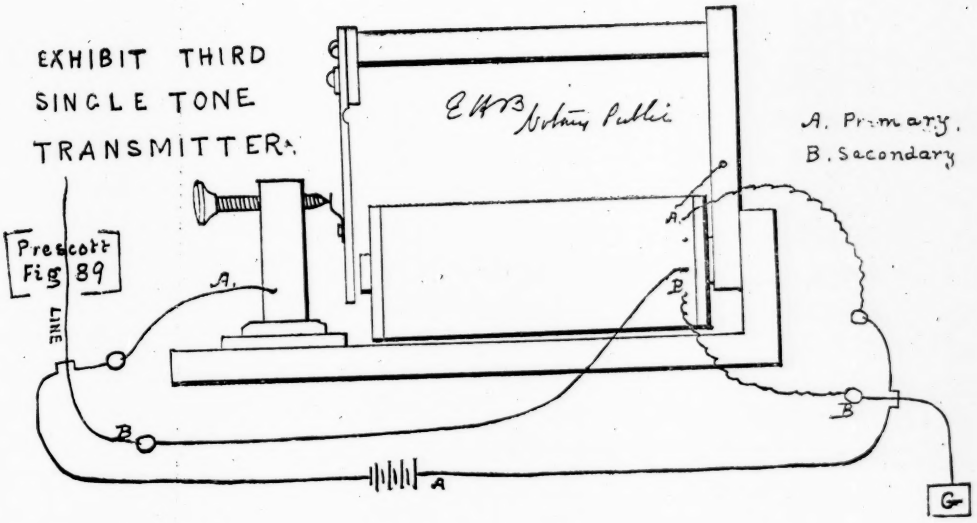
Prescott
Fig. 88.



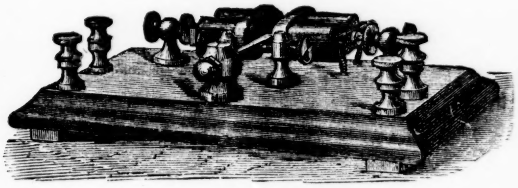
441

E H B
Notary Public

EXHIBIT THIRD
SINGLE TONE
TRANSMITTER.



EXHIBIT, GRAY'S MULTIPLE TRANSMITTER OF 1875.



DIMENSIONS.

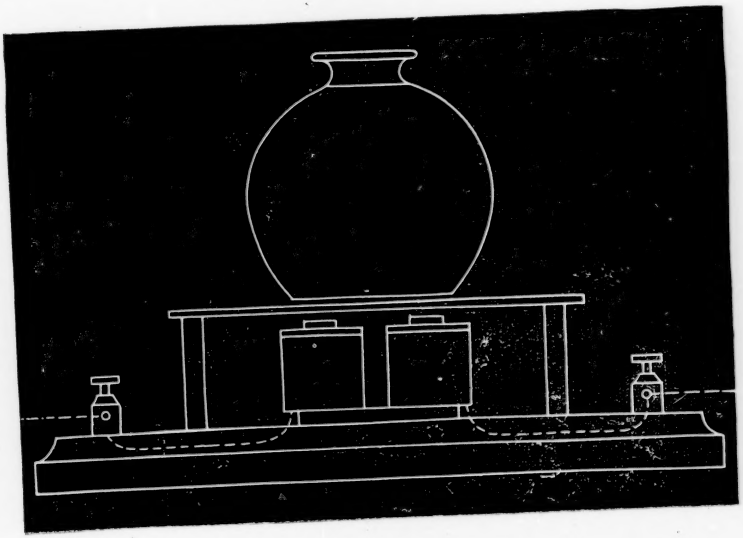
Length of spool,	$1\frac{1}{2}$	inches.
Diameter of spool,	$\frac{7}{8}$	"
Diameter of core,	$\frac{1}{4}$	"
Length of core,	$1\frac{5}{8}$	"
Length of reed,	$3\frac{1}{4}$	"

EXHIBIT, GRAY'S MECHANICAL TRANSMITTER.

DIMENSIONS.

Length of shaft, ... $5\frac{1}{8}$ inches.

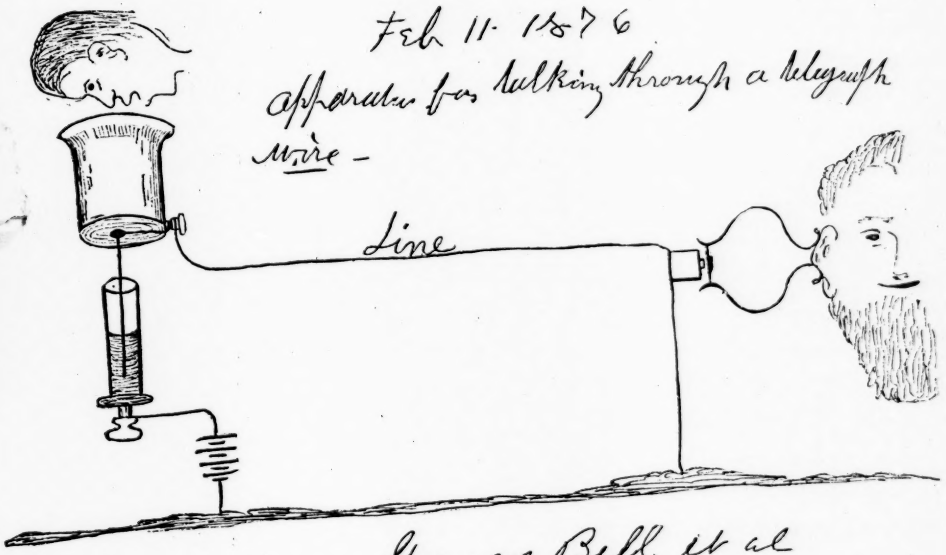
EXHIBIT, GRAY'S GLASS RESONATOR.



450

Feb 11. 1876

Apparatus for talking through a telegraph wire -



Gray vs Bell et al

Speaking Telephone Interferences

a to L

Exhibit Gray Speaking Telephone

Caveat original sketch

Edwd W Beebe

Notary Public

May 7th 1880.

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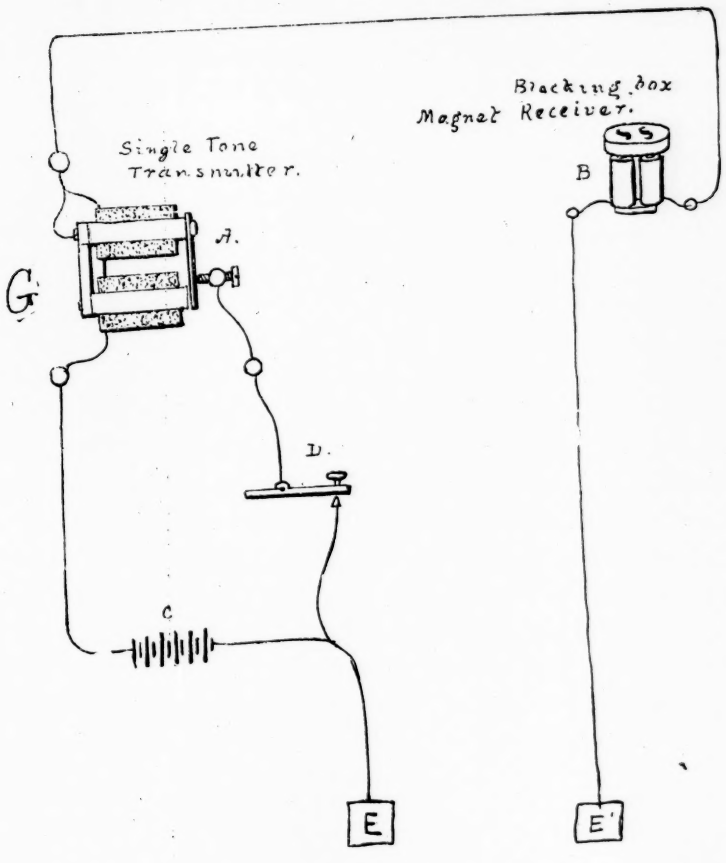
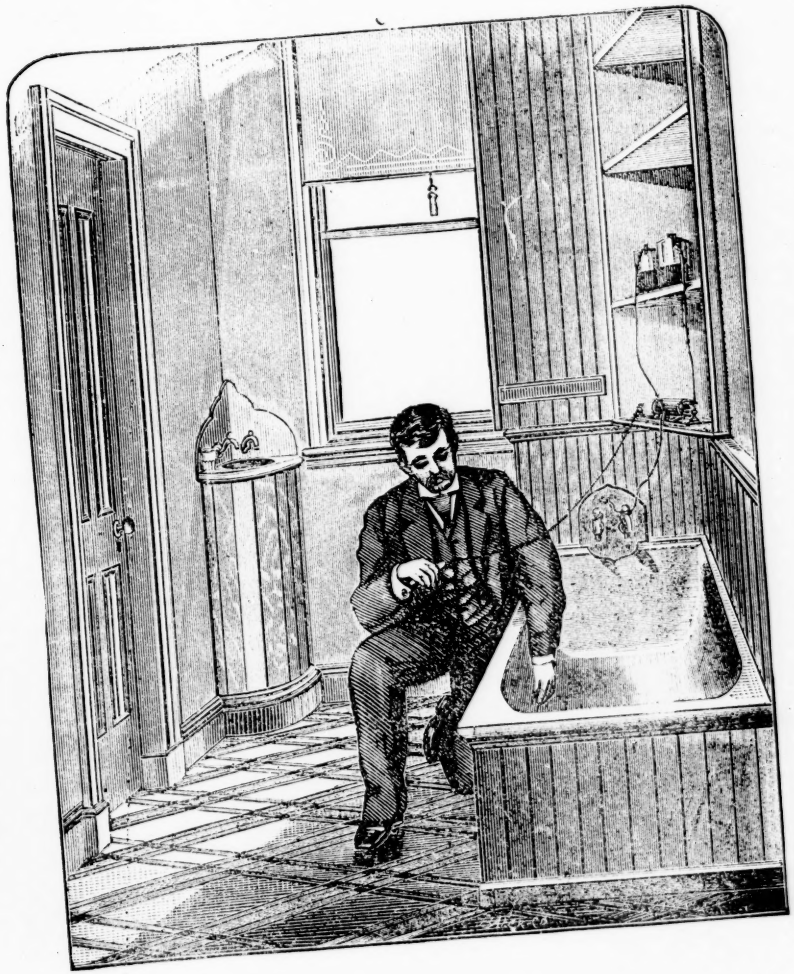
Grays Circuit Connections



Gray vs Bell et al
Speaking Telephone Interferences
a to L.
Exhibit Gray's Circuit Connections
Edwd A Bailey
Notary Public



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DEPARTMENT OF THE INTERIOR

UNITED STATES PATENT OFFICE.

To all Persons to whom these Presents shall come, Greeting:

This is to Certify that the annexed is a true copy from

Files of this Office of the Caveat

of E. Elisha Gray Filed

February 14 1876. for

"Art of Transmitting Vocal

Sounds Telegraphically

In testimony whereof, I, W. A. Doolittle

Acting Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this Twenty Eighth day of March, in the year of our Lord one thousand eight hundred and seventy-eight, and of the Independence of the United States the one hundred and second.

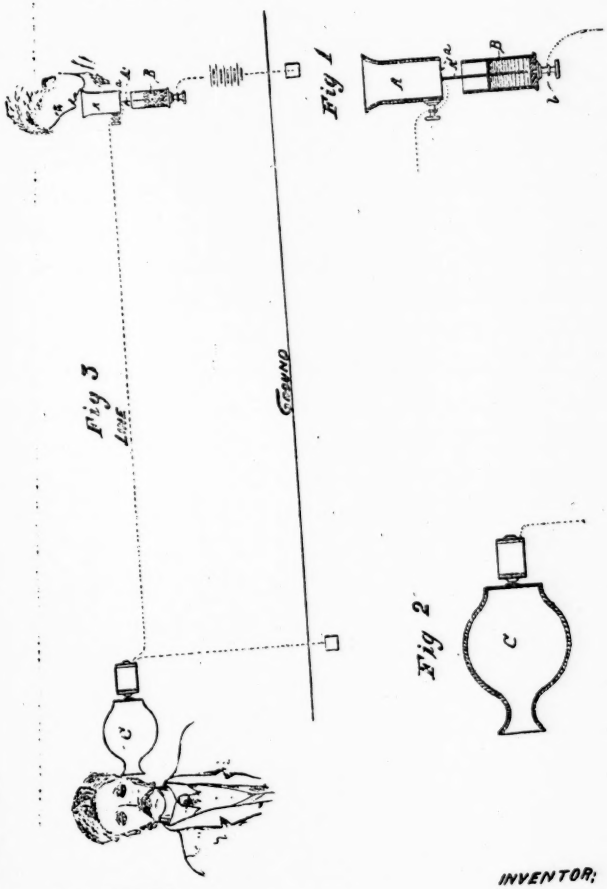
W. A. Doolittle

Acting Commissioner.

ELISHA GRAY

INSTRUMENTS FOR TRANSMITTING AND RECEIVING VOCAL SOUNDS TELEGRAPHICALLY

CAVEAT FILED FEBRUARY 14TH 1876



WITNESSES.

Wm A Skinkle

F Smith

INVENTOR:

Elisha Gray

455

UNITED STATES PATENT OFFICE.

[ELISHA GRAY, OF CHICAGO, ILLINOIS.]

[TRANSMITTING VOCAL SOUNDS TELEGRAPHICALLY.]

SPECIFICATION.

To all whom it may concern:

Be it known that I, ELISHA GRAY, of Chicago, in the County of Cook, and State of Illinois, have invented a new Art of Transmitting Vocal Sounds Telegraphically, of which the following is a specification:

It is the object of my invention to transmit the tones of the human voice through a telegraphic circuit and reproduce them at the receiving end of the line, so that actual conversations can be carried on by persons at long distances apart.

I have invented and patented methods of transmitting musical impressions or sounds telegraphically, and my present invention is based upon a modification of the principle of said invention, which is set forth and described in Letters-Patent of the United States, granted to me July 27th, 1875, respectively numbered 166,095, and 166,096, and also in an application for Letters-Patent of the United States, filed by me, February 23d, 1875.

To attain the objects of my invention, I devised an instrument capable of vibrating responsively to all the tones of the human voice, and by which they are rendered audible.

In the accompanying drawings I have shown an apparatus embodying my improvements in the best way now known to me, but I contemplate various other applications, and also changes in the details of construction of the apparatus, some of which would obviously suggest themselves to a skillful electrician, or a person versed in the science of acoustics, on seeing this application.

Figure 1, represents a vertical central section through the transmitting instrument;

Figure 2, a similar section through the receiver; and

Figure 3, a diagram representing the whole apparatus.

My present belief is, that the most effective method of providing an apparatus capable of responding to the various tones of the human voice, is a typanum, drum or diaphragm, stretched across one end of the chamber, carrying an apparatus for producing fluctuations in the potential of the electric current, and consequently varying in its power.

In the drawings, the person transmitting sounds, is shown as talking into a box, or chamber, A, across the outer end of which is stretched a diaphragm *a*, of some thin substance, such as parchment or gold-beaters' skin, capable of responding to all the vibrations of the human voice, whether simple or complex. Attached to this diaphragm is a light metal rod A′, or other suitable conductor of electricity, which extends into a vessel B, made of glass or other insulating material, having its lower end closed by a plug, which may be of metal, or through which passes a conductor *b*, forming a part of the circuit.

This vessel is filled with some liquid possessing high resistance; such for instance as water, so that the vibrations of the plunger or rod A′, which does not quite touch the conductor *b*, will cause variations in resistance, and, consequently, in the potential of the current passing through the rod A′.

Owing to this construction, the resistance varies constantly, in response to the vibrations of the diaphragm, which, although irregular, not only in their amplitude, but in rapidity, are nevertheless transmitted, and can, consequently, be transmitted through a single rod, which could not be done with a positive make and break of the circuit employed, or where contact points are used.

I contemplate, however, the use of a series of diaphragms in a common vocalizing chamber, each diaphragm carrying an independent rod, and responding to a vibration of different rapidity and intensity, in which case contact points mounted on other diaphragms may be employed.

The vibrations thus imparted are transmitted through an electric circuit to the receiving station, in which circuit is included an electro-magnet of ordinary construction, acting upon a diaphragm to which is attached a piece of soft iron, and which diaphragm is stretched across a receiving vocalizing chamber *c*, somewhat similar to the corresponding vocalizing chamber A.

The diaphragm at the receiving end of the line is thus thrown into vibration corresponding with those at the transmitting end, and audible sounds or words are produced.

The obvious practical application of my improvement will be to enable persons at a distance to converse with each other through a telegraphic circuit, just as they now do in each other's presence, or through a speaking tube.

I claim as my invention the art of transmitting vocal sounds or conversations telegraphically, through an electric circuit.

Witnesses: ELISHA GRAY.

WILLIAM J. PEYTON.

WM. D. BALDWIN.

STATE OF.....
COUNTY OF.....*District of Columbia.* } *ss.*

ELISHA GRAY, the within named petitioner, being duly sworn, doth depose and say that he verily believes himself to be the original and first inventor of the Art of Transmitting Vocal Sounds, described in the foregoing specification; that he does not know or believe that the same was ever before known or used; and that he is a citizen of the United States.

ELISHA GRAY.

Subscribed and sworn to before me, this 14th day of February, A. D. 1876.

[SEAL.] JOHN T. ARMS, *Notary Public.*

[PETITION.]

To the Commissioner of Patents:

The petition of ELISHA GRAY, of Chicago, in the County of Cook, in the State of Illinois, respectfully represents, that he has made certain improvements in the Art of Transmitting Vocal Sounds Telegraphically, and that he is now engaged in making experiments for the purpose of perfecting the same, preparatory to applying for letters patent therefor.

He, therefore, prays that the subjoined description of his invention may be filed as a caveat in the confidential archives of the Patent Office.

ELISHA GRAY.

PATENT OFFICE.
FEB. 14, 1876.
U. S. A.
[Official Stamp.]

OFFICE LETTER.

Feb. 19, 1876.

NOTICE TO CAVEATOR.

Copy sent
Feb. 19,
S. R. A.

DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
WASHINGTON, D. C., FEB'Y 19, 1876.

SIR: You are hereby notified that application has been made to this Office for Letters-Patent for Telephonic Telegraph, &c., with which the invention described in your caveat, filed on the 14th day of February, 1876, apparently interferes, and that said application has been deposited in the

confidential archives of the Office under provision of Section 4,902 of the Revised Statutes of the United States, which section reads as follows:

SECTION 4,902. Any citizen of the United States who makes any new invention or discovery and desires further time to mature the same, may, on payment of the fees required by law, file in the Patent Office a caveat, setting forth a design thereof, and of its distinguishing characteristics, and praying protection of his right until he shall have matured his invention. Such caveat shall be filed in the confidential archives of the Office and preserved in secrecy, and shall be operative for the term of one year from the filling thereof, and if application is made within the year by any other person for a patent with which such caveat would in any manner interfere, the Commissioner shall deposit the description, specification, drawings, and model of such application in like manner in the confidential archives of the Office, and give notice thereof, by mail, to the person by whom the caveat was filed. If such person desires to avail himself of his caveat, he shall file his description, specification, drawings, and model within three months from the time of placing the notice in the post-office in Washington, with the usual time required for transmitting it to the caveator added thereto; which time shall be endorsed on the notice. An alien shall have the privilege herein granted if he has resided in the United States one year next preceding the filing of his caveat, and has made oath of his intention to become a citizen.

If you would avail yourself of your caveat, it will be necessary for you to file a complete application within three months from date, three days additional, however, being allowed for the transmission of this notice to your place of residence.

Very respectfully,

R. H. DUELL, *Commissioner.*

ELISHA GRAY,
Care W. D. Baldwin, *Present.*

EXAMINER'S ROOM NO. 118,
U. S. PATENT OFFICE,
WASHINGTON, D. C., FEB'Y 19, 1876.

E. GRAY, care W. D. Baldwin.

In relation to the foregoing notice in relation to your caveat, it may be well to add that the matters in the app'n referred to seem to conflict with your caveat in these particulars, viz:

1st. The receiver set into vibration by undulatory currents.

2d. The method of producing the undulations by varying the resistance of the circuit.

3d. The method of transmitting vocal sounds telegraphically by causing these undulatory currents, etc.

Z. F. WILBER, *Examiner.*

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(OFFICE LETTER.)
Feb. 25, 1876.

Copy sent
Feb. 25,
S. R. A.

EXAMINER'S ROOM No. 118,
U. S. PATENT OFFICE,
WASHINGTON, D. C., FEB'Y 25, 1876.

E. GRAY, care W. D. Baldwin, *Present.*
Caveat for Art of Transmitting Vocal Sounds Telegraphically.

Feb'y 14, 1876.

The notice to complete having been given under a misapprehension of the rights of the parties, is hereby withdrawn.

Z. F. WILBER, *Examiner.*

$10 Mail.

MEMORANDUM OF FEE PAID AT
U. S. PATENT OFFICE.
Paper will be filed to-day.

INVENTOR,
E. Gray.

CAVEAT.

INVENTION,
Transmitting Vocal
Sounds Telegraphically.

DATE OF PAYMENT,
Feb'y 14, 1876.

FEE,
$10.

SOLICITOR,
Wm. D. Baldwin.

PATENT OFFICE,
FEB. 14, 1876.
U. S. A.

[Official Stamp.]

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[FILE WRAPPER.]

1876.

CAVEAT. *Wilber.* 48

No. —

ELISHA GRAY,

Of.....Chicago.....

County of.....Cook.....

State of.....Illinois.....

Art of Transmitting Vocal
Sounds Telegraphically.

Rec'd.....Feb. 14, 1876.....

Petition..... " " " .....

Affidavit..... " " " .....

Specification..... " " " .....

Drawing Within..... " " " .....

Model.....

Cert. dep.....

1 Cash $10.....Feb. 14, 1876.....

Circular.....

2. .....

3. .....

W. D. BALDWIN.

Present.

---

1. Letter to Caveator, Feb'y 19, 1876. [Notice to Complete.]
2. Letter Feb'y 25, 1876.

Simmons

vs.

158	SX.
	58

[OFFICE LETTER.]
[Sept. 20, 1877.]

Copy sent
Sept. 20, 1877.
M. E. S.

DEPARTMENT OF THE INTERIOR,
U. S. PATENT OFFICE,
WASHINGTON, D. C., SEPT. 20TH, 1877.

ELISHA GRAY, care Baldwin, Hopkins & Peyton, *Present.*

SIR: You are hereby notified that application has been made to this Office for Letters-Patent for Speaking Telegraph, involving the use of a series of diaphragms in a common vocalizing chamber, with which the invention described in your caveat, filed on the fourteenth day of February, 1876, renewed Feby. 14, 1877, apparently interferes, and that said application has been deposited in the confidential archives of the Office, under provisions of Section 4,902 of the Revised Statutes of the United States, which section reads as follows:

SECTION 4,902. Any citizen of the United States who makes any new invention or discovery and desires further time to mature the same, may, on payment of the fees required by law, file in the Patent Office a caveat, setting forth the design thereof, and of its distinguishing characteristics, and praying protection of his right until he shall have matured his invention. Such caveat shall be filed in the confidential archives of the Office, and preserved in secrecy, and shall be operative for the term of one year from the filing thereof; and if application is made within the year by any other person for a patent with which such caveat would in any manner interfere, the Commissioner shall deposit the description, specification, drawings and model of such application in like manner in the confidential archives of the Office, and give notice thereof by mail to the person by whom the caveat was filed.

If such person desires to avail himself of his caveat, he shall file his description, specification, drawings, and model within three months from the time of placing the notice in the post-office in Washington, with the usual time required for transmitting it to the caveator added thereto; which time shall be endorsed on the notice. An alien shall have the privilege herein granted, if he has resided in the United States one year next preceding the filing of his caveat, and has made oath of his intention to become a citizen.

If you would avail yourself of your caveat, it will be necessary for you to file a complete application within three months from date, three days additional, however, being allowed for the transmission of this notice to your place of residence.

Very respectfully,

ELLIS SPEAR,
Commissioner of Patents.

MEMORANDUM OF FEE PAID AT
U. S. PATENT OFFICE. 108

INVENTOR,
$10 Elisha Gray.

RENEWAL OF CAVEAT,
Filed Feb. 14, 1876.

INVENTION,
Telegraphy,

DATE OF PAYMENT.
Feb. 14, 1877.

FEE,
$10.

WM. D. BALDWIN,
Solicitor.

Present.

PATENT OFFICE,
FEB. 14, 1877.
U. S. A.

[Official Stamp.]

[FILE WRAPPER.]

48 1877. *Wilber.*

23

1st Renewal of Caveat of Feb. 14, 1876.

No.

ELISHA GRAY,

Of ..... Chicago .....
County of ..... Cook .....
State of ..... Illinois. .....

165

FILE WRAPPER.

ART OF TRANSMITTING VOCAL
SOUNDS TELEGRAPHICALLY.

Teleloge.

Rec'd ..... Feb. 14, 1877 .....
Petition .....
Affidavit .....
Specification .....
Drawing .....
Model .....
Cert. dept. .....
1. Cash $10 ..... Feb. 14, 1877. .....
2. Circular .....
3.

WM. D. BALDWIN,
Present.

Notice to Caveator.
Sept. 20, 1877.

HUGHES MAY 9, 1878, ARTICLE.

From Scientific American Supplement for June 8, 1878.

[Read before the Royal Society, London, May 9, 1878.]

ON THE ACTION OF SONOROUS VIBRATIONS IN VARYING THE FORCE OF AN ELECTRIC CURRENT.

By Prof. D. E. Hughes.

Communicated by Prof. Huxley, F. R. S., etc. Received May 8, 1878.

The introduction of the telephone has tended to develop our knowledge of acoustics with great rapidity. It offers to us an instrument of great delicacy for further research into the mysteries of acoustic phenomena. It detects the presence of currents of electrity that have hitherto only been suspected, and it shows variations in the strengths of currents which no other instrument has ever indicated.

It has led me to investigate the effect of sonorous vibrations upon the electrical behavior of matter. Willoughby Smith has shown that the resistance of selenium is affected by light, and Bornstein has led us to believe that many other bodies are similarly affected. We know also that the resistance of all bodies is materially influenced by heat. Sir William Thomson and others have shown that the resistance to the passage of currents offered by wires is affected by their being placed under strains, and, inasmuch as the conveyance of sonorous vibrations induces rapid variations in the strains at different points of a wire, I believe that the wire would vary in its resistance when it was used to convey sound. To investigate this, I made a rough-and-ready telephone, with a small bar magnet four inches long, half the coil of an ordinary electro-magnet, and a square piece of ferrotype iron, three inches square, clamped rigidly in front of one pole of the magnet, between two pieces of board. When using the pendulum beats of a small French clock, or the voice, as a source of sound, I found this arrangement supplied me with an extremely delicate *phonoscope*, or sound detector.

All the experiments detailed in this paper were made with the simplest possible means, and no apparatus of any kind, constructed by a scientific instrument maker, was employed. The battery was

a simple Daniells cell, of Minotto's form, made by using three common tumblers, a spiral piece of copper wire being placed at the bottom of each glass and covered with sulphate of copper, and the glass being then filled with well-moistened clay and water. A piece of zinc, as the positive element, was placed upon the clay. Insulated wires were attached to each plate, and three of these cells were joined in series. All experiments were made on a closed circuit, the telephone being used as a phonoscope to detect variations in the current, and the consequent reproduction of sound. The apparatus or materials experimented upon were used in the same way as the transmitter of the speaking telephone of Bell. The attached sketch, Fig. 1, will make this clear. B is the battery, S the source of sound or material examined, T the telephone or phonoscope.

I introduced into the circuit at S a strained conductor — a stretched wire — listening attentively with the telephone to detect any change that might occur when the wire was spoken to, or set into transverse vibrations by being plucked aside. Gradually, till the wire broke, the strain was varied, but no effect whatever was remarked except at the moment when the wire broke. The effect was but momentary, but invariably, at the moment of breaking, a peculiar "rush" or sound was heard. I then sought to imitate the condition of the wire at the moment of rupture, by replacing the broken ends, and pressing them together with a constant and varying force by the application of weights. It was found that if the broken ends rested upon one another with a slight pressure, of not more than one ounce to the square inch on the joints, sounds were distinctly reproduced, although the effects were very imperfect.

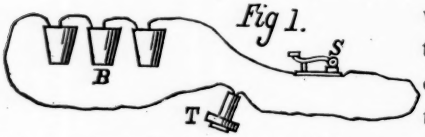

Fig 1.

It was soon found that it was not at all necessary to join two wires endwise together to reproduce sound, but that any portion of an electric conductor would do so even when fastened to a board or to a table, and no matter how complicated the structure upon this board, or the materials used as a conductor, provided one or more portions of the electrical conductor were separated, and only brought into contact by a slight but constant pressure. Thus, if the ends of the wire, terminating in two common nails laid side by side, and

separated from each other by a slight space, were electrically connected by laying a similar nail between them, sound could be reproduced. The effect was improved by building up the nails log-hut fashion, into a square configuration, using ten or twenty nails. A piece of steel watchchain acted well. Up to this point the sound or grosser vibrations was alone produced; the finer inflections were missing, or in other words the *timbre* of the voice was wanting; but in the following experiments the *timbre* became more and more perfect, until it reached a perfection leaving nothing to be desired. I found that a metallic powder, such as the white powder — a mixture of zinc and tin — sold in commerce as "white bronze," and fine metallic filings, introduced at the points of contact, greatly added to the perfection of the result.

At this point, articulate speech became clearly and distinctly reproduced, together with its *timbre;* and I found that all that now remained was to discover the best material and form, to give to this arrangement its maximum effect. Although I tried all forms of pressure and modes of contact — a lever, a spring, pressure in a glass tube sealed up while under the influence of strain — so as to maintain the pressure constant, all gave similar and invariable results, but the results varied with the materials used. All metals, however, could be made to produce identical results, provided the division of the metal was small enough, and that the material used does not oxidize by contact with the air filtering through the mass. Thus platinum and mercury are very excellent and unvarying in their results, while lead soon becomes of such high resistance, through oxidation upon the surface, as to be of little or no use.

A mass of bright round shot is peculiarly sensitive to sound while clean, but as the shot soon become coated with oxide, this sensitiveness ceases. Carbon again, from its surface being entirely free from oxidation, is excellent; but the best results I have been able to obtain at present have been from mercury in a [illegible]ly divided state. I took a comparatively porous non-conductor, such as the willow charcoal used by artists for sketching, heating it gradually to a white heat, and then suddenly plunging it in mercury. The *vacua* in the pores, caused by the sudden cooling, became filled with innumerable minute globules of mercury, thus, as it were, holding the mercury

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in a fine state of division. I have also tried carbon, treated in a similar manner, with and without platinum deposited upon it from the chloride of platinum. I have also found similar effects from the willow charcoal heated in an iron vessel to a white heat, and containing a free portion of tin, zinc, or other easily evaporized metal. Under such conditions the willow carbon will be found to be metallized, having the metal distributed throughout its pores in a fine state of division. Iron also seems to enter the pores, if heated to a white heat without being chemically combined with the carbon as in graphite, and indeed some of the best results have been obtained from willow charcoal, containing iron in a fine state of division.

Pine charcoal, treated in this manner (although a non-conductor as a simple charcoal), has high conductive powers, due to the iron, and from the minute division of the iron in the pores is a most excellent material for the purpose.

Any one of these preparations, confined in a glass tube or a box, and provided with wires for insertion in a circuit, I call a "transmitter."

Reis, in 1860, showed how, by the movement of a diaphragm, intermittent voltaic currents could be transmitted, agreeing in exact number with the sonorous waves impinging on the diaphragm, and thus reproducing music at a distance, by causing an electro-magnet to vibrate in unison with the diaphragm; and with an iron diaphragm, Graham Bell showed how the vibrations of that diaphragm in front of a polarized electro-magnet could similarly induce magneto-currents, corresponding in number, amplitude and form with the sonorous vibration, and thus reproduce all the delicacies of the human voice. Edison and others have produced variations in the strengths of a constant current, by causing the diaphragm to press directly upon some elastic conductor, such as carbon, spongy platinum, etc., the varying pressure upon these materials varying the resistance of the circuit, and consequently, the strength of current flowing. Graham Bell and others have produced the same effect, by causing the vibrations of the diaphragm to vary the electro-motive force in the circuit. It will be seen, however, that in the experiments made by myself the diaphragm has been altogether discarded, resting as it does upon the changes produced by molecular action, and that the variations in the strengths of the currents flowing are

produced simply and solely by the direct effect of the sonorous vibrations.

I have found that any sound, however feeble, produces vibrations which can be taken up by the matter interposed in the electrical circuit. Sounds absolutely inaudible to the human ear affect the resistance of the conductors described above. In practice, the effect is so sensible that a slight touch on the board by the finger nail, on which the transmitter is placed, or a mere touch with the soft part of a feather, would be distinctly heard at the receiving station. The movement of the softest camel-hair brush on any part of the board is distinctly audible. If held in the hand several feet from a piano, the whole cords — the highest as well as the lowest — can be distinctly heard at a distance. If one person sings a song, the distant station, provided with a similar transmitter, can sing and speak at the same time, and the sounds will be received loud enough for the person singing to follow the second speech or song sent from the distant end.

Acting on these facts, I have also devised an instrument suitable for magnifying weak sounds, which I call a *microphone*. The microphone, in its present form, consists simply of a lozenge-shaped piece of gas carbon, one inch long, quarter inch wide at its centre, and one eighth of an inch in thickness. The lower pointed end rests as a pivot upon a small block of similar carbon; the upper end, being made round, plays free in a hole in a small carbon block, similar to that at the lower end. The lozenge stands vertically upon its lower support. The whole of the gas carbon is tempered in mercury, in the way previously described, though this is not absolutely necessary. The form of the lozenge-shaped carbon is not of importance, provided the weight of this upright contact piece is only just sufficient to make a feeble contact by its own weight. Carbon is used in preference to any other material, as its surface does not oxidize. A platinum surface in a finely divided state is equal, if not superior, to the mercurized carbon, but more difficult and costly to construct. I have also made very sensitive ones entirely of iron.

The best form and material for this instrument, however, have not yet been fully experimented on. Still, in its present shape, it is capable of detecting very faint sounds made in its presence. If a

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pin, for instance, be laid upon or taken off a table, a distinct sound is emitted, or if a fly be confined under a table-glass, we can hear the fly walking, with a peculiar tramp of its own. The beating of a pulse, the tick of a watch, the tramp of a fly, can thus be heard at least a hundred miles distant from the source of sound. In fact, when further developed by study, we may fairly look for it to do for us, with regard to faint sounds, what the microscope does with matter too small for human vision.

It is quite evident that these effects are due to a difference of pressure at the different points of contact, and that they are dependent for the perfection of action upon the number of these points of contact. Moreover, they are not dependent upon any apparent difference in the bodies in contact, but the same body, in a state of minute subdivision, is equally effective. Electrical resistance is a function of the mass of the conductor, but sonorous conduction is a function of the molecules of matter. How is it, therefore, that a sonorous wave can so affect the mass of a conductor as to influence its electrical resistance? If we assume a line of molecules, we know that a sonorous wave is accompanied by alternate compressions and rarefactions. If we isolate the part under compression from the part under dilatation, we vary the dimensions of the mass, and we alter its electrical resistance. In any homogeneous conductor of finite dimensions, the effect of the one will exactly compensate for the effect of the other, and we get no variation of current; but if we break up this homogeneous conductor into a series of minute subdivisions, without actually breaking their electrical continuity, we destroy this neutralizing influence, and we render evident the effect of sonorous vibrations in varying the dimensions of the mass of the conductor, and therefore in varying its electrical resistance, for we reduce the length of a portion of the conductor to a fraction of the length of a sonorous wave. Molecular action, alone, explains to me all the effects produced. Size or shape does not effect them. A piece of willow charcoal the size of a pin's head is quite sufficient to produce articulate speech. I regard the action as follows: If we have two separate conductors, joined simply by contact, this contact offers a certain resistance. Now, we can vary or lesson the resistance by increasing the pressure, thus bringing more points in contact, or closer

proximity. Now, as I employ a constant pressure on the contact, which is exactly under the same influence of the vibrations as the points of contact, more points, or closer proximity, can only be obtained through the molecular swelling or movement of the contact points.

If we assume a line of molecules at the point of contact of the minute masses of conducting matter in their neutral condition to be arranged thus, **OOOOO** they will appear thus under compression, **OOOOO** and thus under dilatation, **OOOOO** In the former case the electrical resistance would be *less*, and in the latter case *more*, than in the normal condition. Hence we should get variation in their electrical resistance, and thus sonorous waves could vary the strength of an electric current, and the variations of the electric current can be made to reproduce sonorous vibrations. These, however, would only produce the result in a certain line, say horizontal; but those perpendicular, while producing the same result, would be a half vibration behind, and thus if two contacts, the one horizontal and the other perpendicular, were on the same piece of charcoal and the conducting line joined to both, we should have interference. The contrary takes place, as the more contacts we have, and the more varied their direction on the same, the louder and purer the sound becomes. Hence there is no interference, and consequently the whole mass must swell and diminish equally in all directions at the same instant of time.

The tube transmitter, which I exhibit this evening, consists of an exterior glass tube two inches long and one quarter of an inch in diameter. In it are four separate pieces of willow charcoal, each one quarter of an inch long, and two terminals of the same material. The terminals are fastened in the tube, and connect exteriorly with the line and interiorly with the four loose pieces, thus: —

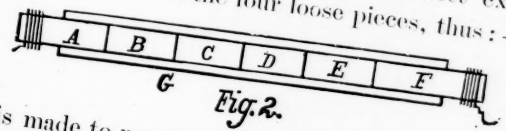

Fig. 2.

Here A is made to press on B, C, D, E, and F, until the resistance offered to the electrical current is about one third that of the line upon which it is to be employed. It may be attached to a resonant board by the ends A or F. If the result was simply due to vibrations,

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we should have A and B making greater contact at a different time from E and F, and consequent interference. If it was a simple shaking or moving of B, C, D, E, and F, it could produce no change, as if B pressed more strongly on C, it would be less on A, and also if the tube was attached by the centre we should have no effect; but if the effect is due to a swelling or enlargement of B, C, D, E, F, it would make no difference where it is attached to the resonant board, as is actually the case. Again, reduce the pressure of A upon B, etc., until they are not in contact, and no trace of current can be perceived by shaking the tube. The instant the sonorous vibrations pass in the tube there is electric contact to a remarkable degree, which could only have taken place by the molecules enlarging their sphere under the influence of the sonorous vibrations.

It is impossible to say what can be the applications of the effects of the discovery which I have had the honor of bringing before the Royal Society, for the whole question has been studied with crude materials, and scarcely sufficient time has elapsed to enable me to consider its ultimate uses. I do not desire to assert that there is anything in what I have brought forward that is superior to or equal to other transmitters used for telephony. It is as loud and far more sensitive than any I have yet heard, and it may be increased by multiplication of transmitting contacts in quantity or intensity; the loudness is at present limited by the capability of the receiver. The materials at my disposal, and the arrangement of them, have not yet been sufficiently studied. I only wished to show that it is possible to transmit clear and intelligent articulate speech, and to render audible sounds which have hitherto been inaudible, by the mere operation of sonorous vibrations upon the conducting power of matter. My warmest thanks are due to Mr. W. H. Preece, electrician to the Post Office, for his appreciation of the importance of the facts I have stated, and for his kind counsel and aid in the preparation of this paper.

I do not intend to take out a patent, as the facts I have mentioned belong more to the domain of discovery than invention. No doubt inventors will erelong improve on the form and materials employed. I have already my reward in being allowed to submit my researches to the Royal Society.

HUGHES JUNE 8, 1878, ARTICLE.

From *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, Vol. VI., Fifth Series, July, 1878, pp. 44-50.

ON THE PHYSICAL ACTION OF THE MICROPHONE.*

BY PROFESSOR HUGHES.

In the paper read on the 9th of May, before the Royal Society, I gave a general outline of the discoveries I had made, the materials used, and the forms of microphone employed in demonstrating important points. I have made a great number of microphones, each for some special purpose, varying in form, mechanical arrangement and materials. It would require too much time to describe even a few of them, and as I am anxious in this paper to confine myself to general considerations, I will take it for granted that some of the forms of instrument and the results produced are already known.

The problem which the microphone solves is this: To introduce into an electrical circuit an electrical resistance, which resistance shall vary in exact accord with sonorous vibrations, so as to produce an undulatory current of electricity from a constant source, whose wave-length, height and form shall be an exact representation of the sonorous waves. In the microphone we have an electric conducting material, susceptible of being influenced by sonorous vibrations, and thus we have the first step of the problem.

The second step is one of the highest importance. It is essential that the electrical current flowing be thrown into waves of determinate form, by the sole action of the sonorous vibrations. I resolved this by the discovery that when an electric conducting matter in a divided state, either in the form of powder, filings, or surfaces, is put under a certain slight pressure, far less than that which would produce cohesion and more than would allow it to be separated by sonorous vibrations, the following state of things occurs: The molecules at these surfaces being in a comparatively free state, although electrically joined, do of themselves so arrange their form, their number in contact, or their pressure (by increased size or orbit of revo-

* Communicated by the Physical Society, having been read June 8, 1878.

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lution), that the increase and decrease of electrical resistance of the circuit is altered in a very remarkable manner, so much so as to be almost fabulous.

The problem being solved it is only necessary to observe certain general considerations to produce an endless variety of microphones, each having a special range of resistance.

The tramp of a fly or the cry of an insect requires little range, but great sensitiveness; and two surfaces, therefore, of chosen materials under a very slight pressure, such as the mere weight of a small superposed conductor, suffice; but it would be unsuitable for a man's voice, as the vibrations would be too powerful, and would, in fact, go so far beyond the legitimate range, that interruptions of contact amounting to the well-known "make and break" would be produced.

A man's voice requires four surfaces of pine charcoal, as is described in my paper to the Royal Society, six of willow charcoal, eight of boxwood, and ten of gas carbon. The effects, however, are far superior with the four of pine, than with either the ten of gas carbon or any other material, as yet used. It should be noted that pine wood is the best resonant material we possess; and it preserves its structure and quality, when converted into the peculiar charcoal I have discovered and described.

It is not only necessary to vary the number of surfaces and materials, in accordance with the range and power of the vibrations, but these surfaces and materials must be put under more or less pressure, in accordance with the force of the sonorous vibrations. Thus for a man's voice, the surfaces must be under a far greater pressure than for the movements of insects. Still, the range of useful effect is very great, as the boxes which I have specially arranged for a man's voice are still sensitive to the tick of a watch.

In all cases it should be so arranged that a perfect undulatory current is obtained from the sonorous vibrations of a certain range. Thus, when speaking to a microphone transmitter of human speech, a galvanometer should be placed in the circuit, and while speaking, the needle should not be deflected, as the waves of + and — electricity are equal, and are too rapid to disturb the needle, which can only indicate a general weakening or strengthening of the current. If the pressure on the materials is not sufficient, we shall have a

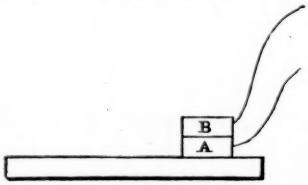
constant succession of interruptions of contact, and the galvanometer needle will indicate the fact. If the pressure on the materials is gradually increased, the tones will be loud but wanting in distinctness, the galvanometer indicating interruptions; as the pressure is still increased, the tone becomes clearer, and the galvanometer will be stationary when a maximum of loudness and clearness is attained. If the pressure be further increased, the sounds become weaker, though very clear; and as the pressure is still further augmented, the sounds die out (as if the speaker were talking and walking away at the same time), until a point is arrived at where there is complete silence.

When the microphone is fixed to a resonant board, the lower contact should be fixed to the board, so that the sonorous vibrations act directly on it. The upper contact, where the pressure is applied, should be as free as possible from the influence of the vibrations, except those directly transmitted to it by the surfaces underneath; it (the upper surface) should have its inertia supplemented by that of a balanced weight. This inertia I find necessary, to keep the contact unbroken by powerful vibrations. No spring can supply the required inertia; but an adjustable spring may be used to ensure that the comparatively heavy lever shall duly pre-s on the contacts.

The superposed surfaces in contact may be screwed down by an insulated screw passing through them all, thus doing away with the lever and spring; but this arrangement is far more difficult to adjust, and the expansion by heat of the screw causes a varying pressure. It is exceedingly simple, however, easily made, and illustrates the theoretical conditions better than the balanced lever I have adopted in practice.

In order to study the theoretical considerations, and that with the most simple form of microphone, freed from all surrounding mechanisms, let us take a flat piece of charcoal two millimeters thick and one centimeter square, and after making electrical contact by means of a copper wire on the lower surface, glue that to a small resonant board, or better for the purpose of observation, to a block of wood ten centimeters square. Upon this superpose one or more similar blocks of charcoal, the upper surface in communication with a wire,

the lowermost surface resting flat, or as nearly so as possible, on the lower block. The required presssure is put on the upper block; and while in this state the two may be fastened together with glue at the sides, or, better, by an insulated screw. The pressure can then be removed, as the screw or glue equally preserves the force. Let the lower piece be called A, and the upper B; when we subject this board to sonorous vibrations, we cannot imagine an undulatory movement of the actual wave-length in such a mass, that is a length comparable with the real wave-length of the sonorous wave, which may be several feet. Nor can we imagine a wave of any length, without admitting that the force must be transmitted from molecule to molecule throughout the entire length; thus any portion of a wave, of which this block represents a fraction, must be in molecular activity.



The lower portion of the charcoal A, being part of the block itself, has this molecular action throughout, transmitting it also to the upper block. How is it that the molecular action at the surfaces of A and B should so vary the conductivity or electrical resistance as to throw it into waves in the exact form of the sonorous vibrations? It cannot be because it throws up the upper portion, making an intermittent current, because the upper portion is fastened to the lower, and the galvanometer does not indicate any interruption of current whatever. It cannot be because the molecules arrange themselves in stratified lines, becoming more or less conductive, as then surfaces would not be required; that is, we should not require discontinuity between the blocks A and B; nor would the upper surface be thrown up if the pressure be removed, as sand is on a vibrating glass. The throwing up of this upper piece B, when pressure is removed, proves that a blow, pressure, or upheaval of the lower portion takes place; that this takes place there cannot be any doubt, as the surface, considered alone (having no depth), could not bodily quit its mass. In fact there must have been a movement to a certain depth; and I am inclined to believe, from numerous experiments, that the whole block increases and diminishes in size at

all points, in the centre as well as the surface, exactly in accordance with the form of the sonorous wave. Confining our attention, however, to points on A and B, how can this increased molecular size or form produce a change in the electrical waves? This may happen in two ways: *first*, by increased pressure on the upper surface, due to its enlargement; or, *second*, the molecules themselves, finding a certain resistance opposed to their upward movement, spread themselves, making innumerable fresh points of contact. Thus an undulatory current would appear to be produced by infinite change in the number of fresh contacts. I am inclined to believe that both actions occur, but the latter seems to me the true explanation, for if the first were alone true, we should have a far greater effect from metal powder, carbon, or some elastic conductor, such as metallized silk, than from gold, or other hard, unoxidizable matter; but, as the best results as regards the human voice were obtained from two surfaces of solid gold, I am inclined to view with more favor the idea that an infinite variety of fresh contacts brought into play by the molecular pressure, affords the true explanation. It has the advantage of being supported by the numerous forms of microphone I have constructed, in all of which I can fully trace the effect.

I have been very much struck by the great mechanical force exerted by this uprising of the molecules under sonorous vibrations. With vibrations from a musical box two feet in length, I found that one ounce of lead was not sufficient on a surface of contact one centimeter square to maintain constant contact; and it was only by removing the musical box to a distance of several feet, that I was enabled to preserve continuity of current with a moderate pressure. I have spoken to forty microphones at once, and they all seemed to respond with equal force. Of course there must be a loss of energy in the conversion of molecular vibrations into electrical waves; but it is so small that I have never been able to measure it with the simple appliances at my disposal. I have examined every portion of my room, — wood, stone, metal, in fact, all parts, — and even a piece of india-rubber: all were in molecular movement whenever I spoke. As yet I have found no such insulator for sound as gutta-percha is for electricity. Caoutchouc seems to be the best; but I

have never been able, by the use of any amount at my disposal, to prevent the microphone reporting all it heard.

The question of insulation has now become one of necessity, as the microphone has opened to us a world of sounds, of the existence of which we were unaware. If we can insulate the instrument so as to direct its powers on any single object, as at present I am able to do on a moving fly, it will be possible to investigate that object undisturbed by the pandemonium of sounds which at present the microphone reveals where we thought complete silence prevailed.

I have recently made the following curious observation. A microphone on a resonant board is placed in a battery-circuit, together with two telephones. When one of these is placed on the resonant board, a continuous sound will emanate from the other. The sound is started by the vibration which is imparted to the board when the telephone is placed on it; this impulse, passing through the microphone, sets both telephone-disks in motion; and the instrument on the board, reacting through the microphone, causes a continuous sound to be produced, which is permanent so long as the independent current of electricity is maintained through the microphone. It follows that the question of providing a *relay* for the human voice in telephony is thus solved.

The transmission of sound through the microphone is perfectly duplex; for if two correspondents use microphones as transmitters and telephones as receivers, each can hear the other, but his own speech is inaudible; and if each sing a different note, no chord is heard. The experiments on the deaf have proved that they can be made to hear the tick of a watch, but not, as yet, human speech distinctly; and my results in this direction point to the conclusion that we only hear ourselves speak through the bones and not through the ears.

However simple the microphone may appear at first glance, it has taken me many months of unremitting labor and study, to bring to its present state through the numerous forms each suitable for a special object. The field of usefulness for it widens every day. Sir Henry Thompson has succeeded in applying it to surgical operations of great delicacy, and by its means splinters, bullets, in fact all foreign matter, can be at once detected. Dr. Richardson and myself

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have been experimenting in lung and heart diseases; and although the application by Sir H. Thompson is more successful, I do not doubt that we shall ultimately succeed. There is also hope that deafness may be relieved. For telephony articulation has become perfect, and the loudness increased. Duplex and multiplex telegraphy will profit by its use, and there is hardly a science where acoustics has any direct or indirect relation which will not be benefited. And I feel happy in being able to present this paper on the results obtained by a purely physical action to such an appropriate and appreciative body as the Physical Society.

In conclusion, allow me to state that throughout the whole of my investigations I have used Prof. Bell's wonderfully sensitive telephone instrument as a receiver, and that it is owing to the discovery of so admirable an appliance that I have been enabled to commence and follow up my researches.

SCIENTIFIC AMERICAN CARBON TELEPHONE ARTICLE.

From Scientific American, June 8, 1878.

THE CARBON TELEPHONE.

Professor Huxley, on May 9th, read before the Royal Institution a communication received the day previous from Professor Hughes, of Kentucky, the well-known inventor of the type printing telegraph, now resident abroad, in which is described, as the original discovery by the author, a new telephone, remarkable for its simplicity, and its astonishing power of magnifying, and so rendering audible the faintest sounds. Professor Hughes claims to have discovered that certain non-homogeneous conducting substances, placed in circuit with a battery, possess the property of converting sonorous vibrations into undulating currents of electricity, by which not only can articulate speech be transmitted to a distant Bell telephone, but the sound is very greatly magnified. It is well known that when contact is made and broken between a battery and a telephone, a loud, dull tick is produced. If, however, the resistance of the circuit or of the battery is suddenly changed, a sound is made in the telephone, but it is of different nature. If, for example, the conducting wire is torn asunder, there is heard a grating noise. The same is audible if the wire be bent, and it would appear that this is owing to the fibres, which constitute the wire, beginning to give way or dragging over one another, producing a variation of resistance.

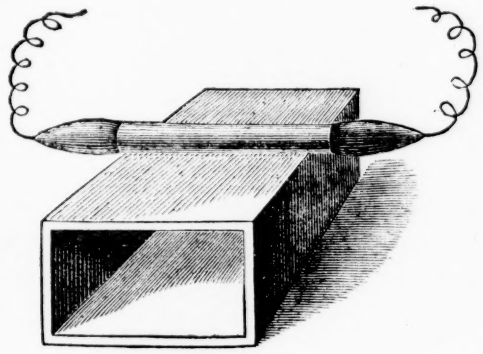


FIG. 1.

Filling a glass tube with a powder of zinc and tin, Professor Hughes closed the extremities with plugs of gas carbon, which slightly compressed the contents. To these plugs the battery wires were attached, and a galvanometer was placed in circuit. On grasping this tube by the ends, and pulling it so as to subject it to tensile strain, the galvanometer needle was deflected in one direction; on compressing the tube endwise, the needle moved the other way. The particles being separated in the first instance, and forced together in the second, the resistance of the circuit was varied, increasing the current in the former case, and decreasing it in the latter.

The only disposition of the tube to fit it for the purpose of a telephone was to attach it to the top of a small box, which served as a resonator, as shown in Fig. 1. Professor Hughes claims to have found that even a piece of vegetable charcoal impregnated with mercury, or with platinum perchloride, answers nearly as well as the tube; and ordinary mechanical structures which contain a good many joints, such as a small machine, or a chain made into a little heap, act almost as well as the substances referred to.

The simplest form of such a structure is shown in Fig. 2, in which two common French nails, A, are fastened down to a horizontal board, about a millimetre apart. Wires, X and Y, are attached to them leading to a battery, B, and a telephone, in such a manner that the nails form the only break in the circuit, which can be closed by laying any conducting material across them. When a third French nail is laid across the other two, it is clear that (as a cylinder can only touch another cylinder whose axis is not parallel with it in a single point) the electric circuit has a very imperfect connection at the points of contact between the nails, and it is to this faulty connection that the sensitiveness of this arrangement is due. This exceedingly simple device transmits sounds with wonderful distinctness and power. The most sensitive contrivance, however, yet devised by Professor Hughes, is represented in Fig. 3. It consists of a little pencil of gas carbon, A, held in small carbon blocks, C, which are attached to a thin sounding-board, secured to a more solid base board, D. The blocks are connected by wires to the battery

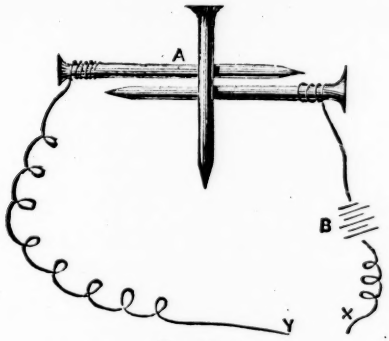


FIG. 2.

and line wire leading to the telephone. This little apparatus not only takes up and transmits articulate speech to a distant station with great power and distinctness, but "it detects and converts into loud noises the minutest possible vibrations." Professor Hughes states that "the tip of a soft camel's-hair pencil gently stroked along the table on which the instrument is placed, is faithfully recorded as a loud rustling sound," and that "the very footfalls of a little common house fly, as it walks along the board, are heard with unmistakable distinctness by a person whose ear is at the distant telephone, which may be miles away."

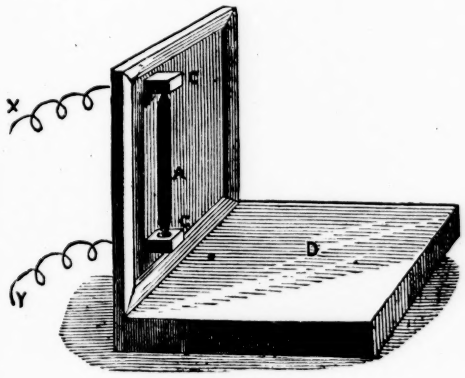


FIG. 3.

The discovery on which all this is based seems to us closely similar to that made over a year ago by Edison. He found that, when

properly prepared, carbon possesses the remarkable property of changing its resistance with pressure, and that the ratios of these changes, moreover, correspond exactly with the pressure. His device for showing the decrease in resistance is represented in Fig. 4. This consists of a carbon disk, two or three cells of battery, and a galvanometer. The carbon is placed between metal plates, through which and the carbon the current passes. When a given weight is placed upon the upper plate, the carbon is subjected to a definite amount of pressure, which is shown by the deflection of the galvanometer needle. The greater the weight, the greater the deflection. Compare this device with Professor Hughes's apparatus for the same purpose represented in Fig. 5. Here the substance to be tested is placed between the jaws at D, and pressure can be increased or diminished by Fig. 4, placing small weights on the bar A,

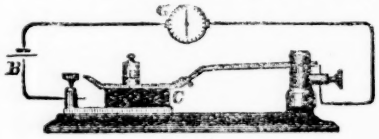


FIG. 4.

on one side or the other of its pivoted centre. The bar is attached through C to the battery B, and the lower jaw is connected with the telephone and battery by the wires X and Y. With this instrument Professor Hughes tested powders and various substances in similar manner to Edison, a telephone being used, and the ticking of a clock observed instead of the deflection of a galvanometer needle. It is hardly necessary to point out to the intelligent reader that the two devices are exceedingly alike; and although Professor Hughes in his communication makes reference to Edison's work, he does not seem to have fully apprehended its close bearing upon, or possible anticipation of, his own. He seems, in fact, to have been oblivious to the various descriptions of Mr. Edison's discovery that have been published here. For example, it would not appear that he had read the description of Mr. Edison's carbon telephone, published in the *Scientific American* of July 28, 1877.

It was, of course, but a step onward for Mr. Edison to substitute

a diaphragm for the weight in his trial apparatus, and to cause the diaphragm to vibrate with varying degrees of pressure against the carbon by the vocal waves. The variations in the current would then cause it to possess all the characteristics of the vocal waves, and by its reaction, through the medium of an electro-magnet, might then transfer them to another disk, causing the latter to vibrate, and thus reproduce audible speech.

Edison's telephone, constructed on this principle, is represented in Fig. 6, in which E is the carbon disk, A the diaphragm, and D and G platinum plates which hold the disk, and which are connected in the battery circuit. In a later device Mr. Edison does away with the vibrating diaphragm altogether, and uses simply a rigid plate of metal to "concentrate a considerable portion of the sonorous waves upon the small carbon disk or button."

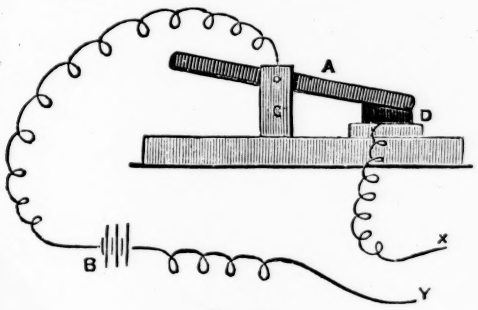


FIG. 5.

The annexed diaphragm, in which the hand denotes the direction of the sound waves, will show the difference which appears to exist in the two devices:

It is of course impossible, without much more evidence than this before us, relative to Professor Hughes's experiments, to reach any certain judgment as between him and Mr. Edison, but a *prima facie* case in favor of the priority of the latter seems to us pretty clearly

made out. As to the transmission of minute sounds, Mr. Edison some time ago informed us of his having achieved that possibility, which, he said, extended to the registration of minute heat waves. Both inventors, however, are American, both are highly distinguished, and both are equally capable of making so important and

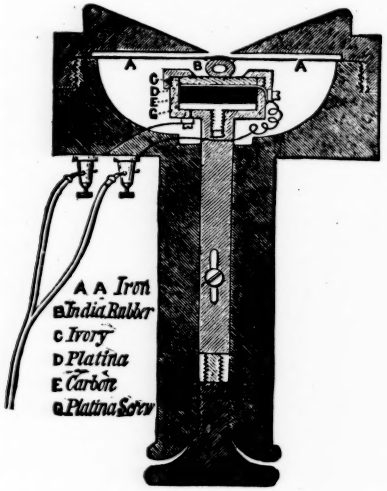


FIG. 6.

creditable a discovery, so that the question we have raised will in no wise, in popular estimation, affect the surpassing value of their work. We are indebted to *Engineering*, and to Mr. George B. Prescott's book on the "Telephone," for our engravings. Professor Hughes's communication to the Royal Society, as read by Professor Huxley, will be found in full in the current issue of the Scientific American Supplement, together with an account of certain practical experiments with some of Mr. Edison's devices.

ARTICLE ENTITLED "CONNECTION BETWEEN SOUND AND ELECTRICITY."

A Lecture delivered by Mr. William H. Preece, before the Society of Telegraph Engineers, May 23, 1878, and printed in the Journal of that Society, Vol. II., page 270.

THE PRESIDENT: I have now the pleasure to call upon Mr. William Preece to favor us with his lecture on "The Connection between Sound and Electricity."

MR. W. H. PREECE: Mr. President, a late member of the present Ministry, at a dinner given by the Institution whose hospitality we experience in this hall, implied, on the authority of one of the leading members of the engineering profession, that invention, like cocktails and Colorado beetles, had taken root in America and had deserted old England. It is therefore to me, as I am sure it is to you, a great gratification to have brought before us an invention which is the offspring of British soil. During the last few months the science of acoustics has made marvellous and rapid strides. First of all we had the telephone, which enabled us to transmit human speech to distances far beyond the reach of the ear and the eye. Then we had the phonograph, which enabled us to reproduce sounds uttered at any place and at any time; and now we have that still more wonderful instrument which not only enables us to hear sounds that would otherwise be inaudible, but also enables us to magnify sounds that are audible; in other words, the instrument which I shall have the pleasure of bringing before you to-night is one that acts towards the ear in the same capacity that the microscope acts towards the eye.

I may point out in the first instance, that the telephone and the phonograph depend essentially upon the fact — and a great fact it is — that the mere vibration of a diaphragm can reproduce all the tones of the human voice. In the telephone, the voice is also made to vibrate a diaphragm, which, by completing an electric circuit, or by varying a magnetic field, or by altering the resistance or electromotive force of the circuit, produces effects at a distance which re-

sult in the reproduction of the motion of the diaphragm; but in this new instrument diaphragms are cast aside, and we have the direct conversion of sonorous vibrations or sound-waves into forms of electrical action.

Now if it had been the habit or custom of this Society, to give to the papers and discourses delivered here sensational titles, I should have been inclined so call the few remarks I am going to make to-night "A Philosopher Unearthed." Professor Hughes is well known to us all. He has been more or less associated with this Society since its first inception. Whenever he is in London he is always amongst us. His instrument is well known to us as one of the most exquisite pieces of mechanism ever invented, and his works, though few, are known because they are sound.

The chief characteristic of this philosopher whom I have succeeded in unearthing is his extreme modesty. If he had been left to himself I do not think we should even have had the microphone here; but by a lucky chance he recently admitted me into his secret, and I am enabled to-night to bring before you the results of his labors, and they have been labors indeed. For months and months he has been working and striving at the ideas which at last he has elaborated into the microphone.

Now, the chief characteristic of the apparatus I am going to introduce to you to-night is its great homeliness, its uncouth roughness, and its absurd simplicity. With common nails, with small pieces of wood, with halfpenny money boxes, with plain sealing-wax, with the ordinary apparatus which every child has at its command, he has been able to attack nature in her stronghold, to ask her questions, and receive back answers, and lay bare to us facts and thoughts which, though they have existed from time immemorial, are brought to light now for the first time.

Now let us, in the first place, ask ourselves this question. What is sound? It is a very difficult question to answer, in the short time at my disposal; but it is necessary I should first say something to you about the nature of sound, and then say something about the nature of electricity, and show you how the one can be converted into the other.

Now, what is sound? While I am speaking to you I am setting

the air in this room into vibration. The air of this room is composed of an infinite number of infinitely small molecules; every molecule is set into motion and vibrates to and fro, backwards and forwards, like the bob of a pendulum, and between my mouth and every one of the ears in this hall there is a rapid but short excursion to and fro of every single molecule that composes the atmosphere of this room, and it is the impinging of these molecules against the drum of the ear that produces that sensation called *sound*. But more than that, not only is the air of this room in this marvellous state of motion, but every piece of wood, every wall, every picture — everything in this hall at this moment — is almost, I may say, alive; trembling away, moving backwards and forwards, forming what are called sonorous vibrations. If the sound be loud enough, and the note deep enough, we can distinctly feel these vibrations. Sound is therefore the vibration, in particular periods and particular phases, of matter.

Now, what is electricity? Faraday, the greatest electrician, perhaps, that ever lived, was asked that question, and he said the more he studied electricity, the more he unravelled its mysteries, the more mystified he became as to its source and its origin; therefore, it seems an act of impudence, on the part of myself, or anybody else, to attempt to answer the question, What is electricity? But great strides have occurred since the days of Faraday; we know a great deal more now of the internal molecular action of bodies; we know that light and heat and sound are the mere action of those molecules of which matter is composed; and we feel sure, from the facts brought to our notice by the delicate apparatus of the present day, that electricity is simply a mode of motion, nothing more nor less than the simple play of the molecules of matter. The truth of this will be made evident to-night by the wonderful connection which exists between sound, which we know to be merely a mode of vibration, and electricity, which will reproduce to us the effects of sound.

To make this evident to us, we must have two instruments; the one a detector, which will render apparent to us any electrical action that shall result in sound; and it fortunately happens that this marvellous telephone is an instrument of such extreme delicacy that it has made us acquainted with *currents* of electricity hitherto unknown, though

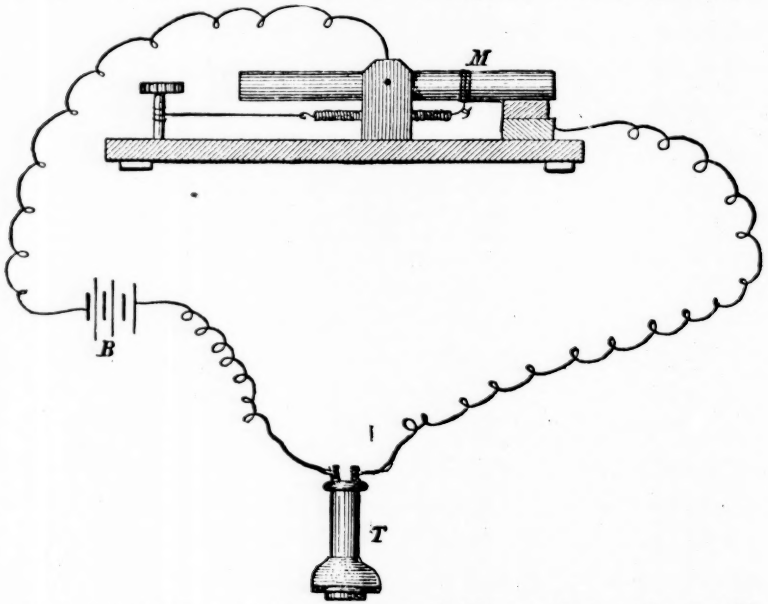
their presence has been suspected. The telephone which Professor Hughes has used in his researches is as simple in its construction as are all his other apparatus. It consists of two rough pieces of board clamped together. There is half the end of an electro-magnet that probably has been in his possession since his early experiments, to judge from its appearance. The magnet is a piece of steel rod that has been magnetized. The wire used, and which he has found extremely useful to him, is wire that was originally made for very different purposes — for ladies' bonnets — and in front of this is placed a piece of ferrotype iron, well known by those who have experimented with the telephone.

But what is the source of sound? It was necessary in making these experiments that he should have a source of sound, something which would generate those sonorous vibrations of which I have spoken. This source of sound was a small mantelpiece clock of French manufacture, which cost originally three or four francs. It has been in use many years, and has been in many parts of the world. It is repaired with great lumps of sealing-wax; but nevertheless it has or ought to have a pendulum, which gives a succession of beats, and those beats form a source of sound. Now, with this source of sound, and this beautiful scientific apparatus, the telephone, as a detector, he started upon one of Sir William Thomson's discoveries, viz., that wires alter their electrical condition when they are placed under strain. He took a piece of wire, applied weights to it, connected the clock with it, and heard nothing. He was not disconcerted; he applied weight after weight till he reached the breaking strain of the wire, and at the moment when the wire broke, he heard a rush or sound which he thought was an indication of what he was searching for; so he took the two ends of his wire and laid them together, placed his sources of sound above them, and to his intense delight heard — what imagination perhaps assisted him in believing to be a tick. He thought he was on the right track, and he then manufactured, with a flat piece of brass for a lever, a pin for an axle, sealing-wax for cement, black wax for solder, and the uncovered bonnet wire for binding, a little apparatus which enabled him to apply constant pressure to the thing he was experimenting upon; in

fact, by this means he was enabled to produce what we electricians call a "bad joint."

To his intense delight he found with this bad joint, and rough, application of pressure by putting various things — pieces of metal, chain, etc. — underneath this little contrivance, he was able to obtain sonorous effects. But this contrivance, simple as it appears, was a great deal too elaborate and complicated for his purpose; so he took two French nails — little bright nails, so much used in France — laid them side by side, not touching each other, and bringing the ends of the wire in contact with them, and laying between or across them a third and similar nail, he was able to reproduce almost perfectly the sound of the clock, and, more than that, he began to get indications of the sound or tone of the voice. He then used chains; he took a gold chain, and put it beneath his little compressor, and with that he was able to speak with great ease. From that he tried filings, and found with matter in a finely divided state he was able to reproduce all the effects of sound. At last he made little glass tubes, about two inches long, filling them with white bronze powder which artists use, which is a mixture of zinc and tin, and he was able to reproduce exactly the tones of the voice. But in his experiments with carbon he was able to make what may be called quite an independent and another discovery. The carbon he experimented with was the common carbon used by artists in sketching their drawings, and this carbon he found to be a non-conductor of electricity. The idea struck him that this non-conductor of electricity might be made a conductor, and by various processes he at last arrived at a plan of boiling or heating this carbon in quicksilver. Carbon so heated in an atmosphere of quicksilver, itself becomes permeated through and through with quicksilver, and by that means we get the mercury subdivided into an almost infinitely pure state. Probably mercury in this state as closely approaches the molecular as anything can do; there is no apparent indication of mercury under the microscope, and yet we know that the carbon has been mercurized, because it is converted from a complete insulator into a conductor, and it has a metallic ring when it falls. Now, then, having by these processes arrived at a substance which is remarkably sensitive to all the variations of the sound of the human voice, his next task was to construct these things

into such a form as to make them telephonic transmitters. For that purpose he brought to his aid a very cheap kind of apparatus, a half-penny money box. Inside this he placed his carbon transmitter; and as this discovery is not fenced in by fear of the patent or any other law, I am quite sure you will be glad to know how to make a Hughes transmitter. First, he takes a piece of one-quarter-inch board about two inches long and one inch broad, and he raises upon that two thin brass bearings, with a hole worked through by means of a pin for the support of his axis. He then takes a piece of carbon about two inches long, which has been mercurized, which has a pin cemented to it near its centre, which acts as an axis, and makes it into a lever. On the board he places another smaller piece of carbon, similarly treated, and upon this rests another similar-sized piece of carbon, the two being connected by a piece of paper. (See figure in which M represents the transmitter, B the battery and T the telephone.)



Now the battery is another remarkable specimen of scientific manufacture. Three little glass tumblers are taken; at the bottom of each a piece of copper wire is coiled spirally. The copper wire is covered with a little sulphate of copper. The tumbler is then

filled with moistened clay, and upon the top of this clay is placed a piece of scrap zinc. The three cells are placed in a cigar box. The tube transmitter consists of a glass tube about two inches long and one-fourth inch diameter, inside which several pieces of mercurized carbon are inserted, touching each other with a pressure regulated by a screw fixed to each end. The size of the carbon appears to be of little consequence. He has produced effects with carbon not larger than the head of a pin. We shall show this by and by; but rather than disturb the order of these researches, I think it advisable in the next place to show you how this principle has been carried a little further to produce what he calls the microphone. This apparatus is extremely sensitive. It will give evidence of nearly any sound; but in the microphone itself, which I have here, this extreme sensitiveness is carried to a still further extent. In point of fact this is a microphone; but in this particular instance, the pressure bearing between the two carbons is regulated by a spring, and it is so regulated that the transmitter is independent of any position in which it may be held. It is free to be moved in any direction, in consequence of the pressure of the spring; but in one form of instrument this spring is dispensed with, and the pressure between the carbons is reduced to its greatest sensitiveness by making the two arms of this lever as short as possible; but in the first machine he used, a piece of carbon was fixed on the top of an upright board of that kind, and a smaller piece was fixed down below. A cup-shaped ball was made at one end, and a similar one at the bottom, resting upon a piece of lozenge-shaped carbon; and this lonzenge-shaped piece of carbon rests with the greatest nicety upon its lower disc, and is just in that position of equilibrum that the slightest atmospheric disturbance produces the effects which we are now about to show you.

I think it desirable to tell you that you must not expect to-night distinct articulations. We have made a violent effort to make these experiments evident to you all.

Now, the effects you have just heard have been produced by a microphone similar to that drawn on the board. We will now repeat the effects with the machine on the table, and in order that you may judge of the effect — for Professor Hughes desires you should see there is no deception — we will connect this up, and use

his old friend, the clock, to make its ticks, if it will, evident over the whole room. One of the greatest effects which this instrument produces, is to render evident the tramp of a fly, and we have some nice little captives with which we will demonstrate that effect at the close of the meeting, (*Illustration with clock.*)

To show that the sounds come from the clock itself, Professor Hughes will lift up the clock, when all traces of sound will have disappeared, and on putting it down again, the sounds will be produced; so that the sound you hear is the sound of that clock, which has been magnified.

Now, we have here a common quill pen, and Professor Hughes will do as they do on the stage, pretend to write a letter, and I have no doubt if you listen attentively, you will hear the scratching of his pen. (*Illustrated.*)

Now, there are some peculiarities in this apparatus that are very striking. In the first place, though the sounds produced are very great, they do not interfere with each other, If you have a friend at the other end speaking to you, you can hear his voice distinctly working through your voice, and the result is, you get a duplex action. Two or three persons can talk to each other without impediment or confusion.

Yet another point is, that the articulation is absolutely perfect. One of the great difficulties, both in the telephone and the phonograph, is getting the noises and sibilant sounds reproduced, such as *s* and *c* and *sh*, which are produced by such extremely minute variations in the sonorous vibrations that they are lost in those instruments. Thus, if through the telephone you ask a person to waltz, it will come out "walk," and names like my own, with the sound of *s* in it, though it is spelt with a *c*, would come out "Pree," not Preece. In this transmitter, one of its chief peculiarities is the fact that all sounds are faithfully reproduced, and it tends very much to upset the notion — Helmholtz's theory — that vowel sounds, and other sounds, are due to the superposition of waves upon waves of tones and overtones. This apparatus shows, almost unquestionably, that all these different properties, all these effects of intonation, are due to differences in the form of the wave sent. Another peculiarity is this. I have told you that all in this room,

every one's body while I am speaking, is alive with sound. If you take this transmitter and place it in front of your mouth, or put it on your forehead, or on the top of your head, or put it in your pocket, or upon your breast, it will still transmit sounds to distant places. Put it in a room, it does not matter where, it will reproduce the sounds. Put it anywhere in a drawing-room where there is a piano, you will hear the sounds of the piano faithfully reproduced. It is, as you see, a marvellously rough affair; you may throw it up, kick it about, and do what you like with it; it will always act. Here is the identical box that Professor Hughes made two or three months ago; it has never been touched; it has been always at work, and never needs repair.

These are some of the peculiarities of this instrument, and I dare say some of you would like to know a little about its theory. We have here two points in contact, and those two points in contact complete an electrical circuit. The electric current that flows through that circuit depends for its strength entirely upon the obstacles or resistances, in that circuit, to the flow of the current. Any alteration in any shape or form in the resistance of that circuit will result in the increase or decrease of the strength of the current flowing; and upon this board I will make a rough attempt to endeavor to give you an idea of what occurs. You must not conceive that these round balls are molecules themselves; they are merely meant to represent the sphere of action of each molecule at each point of contact. In a normal state the molecules rest against each other, as shown by the upper line. When, from any cause, pressure is increased, they are contracted, as shown in the second line; when, from any cause, the pressure is decreased, they expand in the form shown on the other line. While I speak at you, the air of this room is thrown into vibration, the mass of air being subdivided into molecules in compression and molecules in extension. In a long wire, these successions of compressions and extensions compensate each other; but when we break up a body into infinitely small parts, when we make contact between two bodies as shown there, we isolate the portion of the sonorous wave in compression from that in extension, the result is that we have a variation in the resistance of the line. Now this variation in resistance depends upon the compression and

dilatation of the molecules. It depends upon the tone of the voice, and the result is, the resistance of the current varies with its variation of pressure, and at the distant end we have currents varying exactly as the voice varies, and reproducing on the telephone all the effects which we have seen. Hence follows the action of the microphone, which depends upon the variation produced in the contact of bodies by the sonorous vibrations of the voice. As I am now speaking at that microphone. all the molecules of that transmitter are thrown into this elaborate series of compressions and dilatations. The current is varied; the current goes to the room below, and is reproduced upon the telephone, as we have heard. Hence the effect is due to the difference of pressure at the points of contact, as is proved by using atmospheric pressure, applying heat, making noises, and any large variation of pressure results in sound being reproduced.

No one has ever been nearer a great discovery than Mr. Edison. His telephone is based on the variation of resistance in carbon due to pressure. He used carbon and finally divided matter; but he worked on the idea that the difference in pressure was produced by the vibration of a diaphragm. Had he thrown away his diaphragm, he would have forestalled Professor Hughes in this respect, and found that the sonorous vibrations themselves produced this difference of pressure.* The great secret of Professor Hughes's discovery is that sonorous vibrations and electrical waves are to a certain extent synonymous.

Now, as to the uses to which this instrument is capable of being applied. It has been applied to surgical purposes in the form of a stethoscope. Though it does not show very markedly the beats of the heart, because they are more mechanical thumps than sonorous vibrations, yet it will show the injection and ejection of air in the lungs, and for many other surgical purposes it must become a valuable instrument. It admits us to some of the mysteries of insect life, and by its means we can hear sounds emitted by insects which have never been heard before. Going further, it has enabled the deaf to hear; deaf persons

* It appears that Mr. Edison actually did this, but he was anticipated by Professor Hughes.

who never heard a telephone before have been able to hear distinctly. It has enabled us to hear the physical operation which goes on in the process of crystallization of bodies, and other things which before were wholly inaudible, and in fact it is impossible to say to what uses it may not be put.

It is rather remarkable that in an excellent paper read before the American Electrical Society, the author, Mr. Pope, makes these curious remarks: —

"The most striking results are to be looked for in the direction first pointed out by Mr. Gray, for the reason that if an effectual method of controlling the resistance of the circuit by means of atmospheric vibrations can be discovered, the source of power, which in this case is the battery, may be augmented to any required extent. It is not to be denied that the problem thus presented is one of exceeding mechanical difficulty, but there is no reason to suppose that it may not be successfully solved. It is to the development of this variety of speaking telephone, rather than to that of the magneto instrument that inventors will find it most advantageous to turn their attention; for I hazard little in saying that the latter has already reached such a surprising degree of efficiency, as to leave comparatively little more to be done within the necessary limitations which have been pointed out."

Mr. Pope throws out as a suggestion what has now been done, with the exception of the supposed mechanical difficulty, and that has been got over by a halfpenny money box.

Now, one very pleasing and gratifying circumstance attaches to this discovery of Professor Hughes. He has thrown it open to the world, and by that means he has no doubt checked that species of immorality (I don't know what else to call it) connected with the infringement of the patent law as regards the telephone. He allows us all to manufacture microphones for ourselves; but even he has been subject to rather a peculiar incident. One impulsive and active gentleman, who was present at the Royal Society the other night when Professor Hughes first described his invention, went home and made himself a microphone, wrote a description of it, and sent it off post haste to Paris. A short time afterwards, Professor Hughes himself with great care prepared a paper to be read before the French Academy, bnt to his great surprise he found that he had been forestalled; a description of his instrument had already appeared in the Paris prints from the gentleman in question.

There are lessons to be learnt from this discovery; and the principal lesson is, we can all of us, with the means at our disposal, cross-question nature and find out her secrets, and there are many secrets which yet remain to be divulged. We learn the wonderful connection which exists between all the physical forces; heat and light, and electricity and magnetism, are all co-related; and it has come to this, that what boys have said in joke, has come to pass in earnest. We have been able to convert electricity into light, and light into electricity. We are now able to convert electricty into sound, and sound into electricity, and thus we are enabled to see the thunder and to hear the lightning.

THE PRESIDENT: We have listened to a very interesting and instructive address, and I hope it will be followed by an equally interesting discussion. I see many here who are fully able to take part in it, and, with your permission, I will call upon his Grace the Duke of Argyll to open the discussion.

THE DUKE OF ARGYLL, K. G., rose and said: Mr. President and gentlemen, — Though I am a stranger here, I am very glad of the opportunity which the kind invitation of your President gives me to say a few words as to the extreme interest with which I am sure we have all heard the admirable lecture just delivered by Mr. Preece; one which, for interest of matter and for clearness of exposition, I have never heard excelled in the course of my experience of scientific lectures. It is quite obvious that we are here in the presence of many of the most remarkable discoveries of an age which is full of discoveries; discoveries which are sure to be utilized in a thousand ways which at present we cannot foresee. Mr. Preece has said at the beginning of his lecture that he rejoices, on this occasion, at least, that the progress of this discovery has taken place on English soil. On further inquiry, however, I am not sorry to find that the distinguished man whose discovery has just been explained, is, although a resident in this country, a citizen of America; because, though I have as strong a patriotic feeling as any gentleman present in this assembly, I am one of those who, in matters of science, are thoroughly cosmopolitan in the triumphs of human intellect, by whatever nation they may be made, and further, I am one of those who feel that the citizens of America are, after all, our

fellow-countrymen. Now, with regard to the uses to which this discovery may be put, there are many which immediately suggest themselves to one's imagination.

I am sorry to hear from Mr. Preece, that the immediate application of it, in so far as it has yet been tried, to the sounds of the human heart, does not throw much additional light on that most curious matter, the circulation of the blood, because probably the sounds are of a muffled nature, and do not give rise to sonorous waves such as those which have been explained to us; but I cannot doubt for a moment that one of the most immediate applications of this very valuable discovery will be a surgical application, and that through it our medical men will be able to pronounce upon a series of diseases with which we are at present wholly unacquainted. Now, being myself accustomed to think a good deal about political affairs, I confess I was struck with some of the inconveniences which might occur through the agency of this discovery. We are now very close, you know, to Downing Street, and it occurred to me if you placed one of these little halfpenny boxes in the room where the Cabinet sits, we should have the whole of the secrets of the Cabinet revealed in this hall of the Civil Engineers (laughter); or if by any extraordinary ingenuity, such as many conjurers can command, one of these little boxes could be inserted in the pocket of my distinguished friend Count Schouvaloff or Lord Salisbury, I have no doubt we should be at this moment in possession of all those secrets which the whole of this country and of Europe are desirous to know. I should like to know from Professor Hughes that there is some means of preventing this. I remember a lady friend who was very fond of attending sermons, and she was laid up by a complaint which prevented her going to church; but she contrived to take a lodging almost under the roof of the church where a celebrated minister preached, and she had a speaking trumpet fixed near the pulpit, and by that means she was able to enjoy the sermons she so much desired to hear. But with this instrument of Professor Hughes we shall be able to poach on every one's manor, and know every one's secrets; and I should much like to know from Professor Hughes whether, since one of these little boxes set anywhere in a room is capable of transmitting to a distance all the conversation which takes place in that room, he is able to provide an antidote for it.

DR. LYON PLAYFAIR, M. P.: I can only sympathize with the remarks which my noble friend the Duke of Argyll has just made to us. In fact, one sees no end to the application of this discovery. I have no doubt before long Professor Hughes will connect his instrument with the aerophone which magnifies sound so that one can hear it over four or five square miles. Only conceive what might happen in a debate in which such orators as the noble duke who has just sat down or Mr. Gladstone made one of their magnificent speeches; supposing one of these instruments were connected with the aerophone, and instead of those speeches being confined to the area of St. Stephen's, they were sent over four square miles of London, and allowed millions of the public to enjoy the beneficial effects of that eloquence! It is not only possible but probable. Only conceive to what large influences such a discovery as this may lead. Or supposing you connect this instrument with the opera house, where one of our great contraltos or sopranos are singing, it would be possible by means of the aerophone to communicate it to a whole town. The development of this instrument, in connection with others already in existence, may be productive of prodigious effects. I think in the hands of the physician it will prove to be a discovery of the greatest importance and value. It occurred to me that though the muffled sounds of the heart might not be adapted for repetition, it might be possible in acute diseases, such as inflammation, or other acute diseases which proceed from too energetic action in particular parts of the body, it occurred to me that these might be detected by this agency. In the beginning of a discovery of this kind it is impossible for the most lively imagination to see the results that may flow from it; and in the hands of Professor Hughes, or in the hands of others, it is impossible to place a limit to the development which may result from the description we have heard to-night. I consider it one of the most remarkable discoveries of modern times, and I congratulate Professor Hughes upon it. He is a citizen of a country to which I am dearly attached by many acts of kindness shown to me; at the same time he has been so long connected with this country, that we may fairly claim this as the joint discovery of two great nations.

MR. WILLOUGHBY SMITH: Marvellous discoveries have been

brought before us lately in such quick succession, that I am pleased we have at length an opportunity to pause and reflect on what we have already seen and heard. I cannot agree with Mr. Preece in his molecular and sound-wave theory of the microphone. I believe the phenomena to be solely due to what is known as a varying contact, and that the microphone is nothing more than a sensitive commutator. Mr. Preece has told us that by the aid of the microphone the tramp of a fly can be heard, resembling that of a horse walking over a wooden bridge; but I can tell you something which, to my mind, is still more wonderful; that by the aid of the telephone I have heard a ray of light fall on a bar of metal. This may appear a startling statement, but with the whole facts before you, it will become extremely simple. I have, on a previous occasion, shown that the electrical resistance of selenium is very much reduced immediately it is exposed either to solar or artificial light; consequently if a bar of selenium, excluded from the light, form part of a circuit in which are included a battery, a telephone, an electrical bell, and a galvanometer, nothing will be heard until the light be allowed to fall upon the selenium, which is done simply by raising the lid of the box in which the selenium is placed, when immediately sound is heard in the telephone, the bell rings, and the needle of the galvanometer moves, simply because the resistance of the circuit is reduced, and consequently the electro-motive force increased. Now, when I read that Professor Hughes had discovered that bodies were susceptible to sound as selenium to light, I removed the selenium from the circuit, and substituted every substance I could think of in its place, and used every conceivable means to produce sound, but without effect. But if, in a metallic circuit, be placed either a loose contact, or a sensitive commutator, then one can produce all the phenomena claimed for the microphone. I have obtained very satisfactory results from three very fine "rat-tail" files placed in the circuit, similar to the letter H, one end of each of the side files being fixed, and the other file simply lying across them; the longer the side files, and the nearer the cross one is placed to the unsupported ends of the other two, the better; if the cross file be replaced by loose threads of metallized silk, and a spirit lamp be placed beneath the same, so as to create a draught, then is heard in the

telephone a noise similar to the sound of the burning wick of the lamp, especially when first lighted. What Professor Hughes has discovered is, that by allowing the breath or other motive power to affect a sensitive loose contact or commutator, contacts of varying duration are made, which are reproduced in corresponding sounds on that marvellous instrument, the telephone. This is an important discovery, and Professor Hughes has my hearty congratulations.

Mr. Latimer Clark: I did not intend to make any observations, and I feel almost out of place, after the eloquent addresses we have heard, in going back to the ordinary technical view of the subject; but I would just remark that Mr. Preece has, I think, omitted to mention one of the experiments of Professor Hughes. The little glass cylinder you see here (*exhibiting*), with small segments of willow-wood carbon dipped in mercury, is extremely sensible to heat; so much so, that the approach of the hand or other warm body causes very great variation in the resistance of the circuit, and also causes a noise in the telephone. So does a slight alteration of the pressure on the end. If you press on the end of the tube, you cause a noise in the telephone, and produce great deflection of the needle of the galvanometer. You might make a sensitive relay by causing a needle or an electro-magnet to slightly compress the segments in this tube, which would doubtless be more sensitive to delicate currents than any relay we have at present. I therefore throw out the suggestion, in order to make it public. I also think a very excellent Morse sounder may be made from the microphone, by causing a continual sound to be produced in the telephone, and it is obvious that one source of movement would cause any number of instruments in an office to produce continuous sounds, the signals would be received on a relay, and would come out, not as dots, but as dots and prolonged dashes, which could be more accurately and easily read than the ordinary sound signals.

Lord Lindsay, M. P., F. R. S.: I will only mention one experiment which struck me as being interesting. I constructed one of Professor Hughes's little instruments from a description which I read of it, and having stretched a piece of parchment over a circular frame so as to form a vibrating membrane, I attached to its centre a piece of carbon, which was connected in circuit with a battery by means of a fine copper wire. Against this piece of carbon I placed

a second similar piece, so arranged that I could increase or diminish its pressure upon the first piece by means of an adjusting screw, and to this piece was also attached a copper wire, by which it could be placed in circuit with a battery and telephone, and with the other piece of carbon. Under the influence of sonorous vibrations the membrane vibrated, and in doing so produced a variation in the pressure, and consequently in the electrical contact between the pieces of carbon, reproducing the original sounds in the distant telephone. On one occasion I placed the apparatus on the sounding board of a pianoforte upon which my little girl was practising (she was playing scales), and I noticed a very remarkable effect. Whenever one particular note was struck, a harsh loud sound was heard in the distant telephone, although all other notes were clearly transmitted and reproduced. On examination, I found that the note which produced this curious effect was that whose period of vibration corresponded with that of the membrane, and in the sound produced could be heard the fundamental note and overtones, as well as the octaves and other sympathetic notes sounded by the strings of the pianoforte.

PROF. GRAHAM BELL: No one can more heartily congratulate Professor Hughes upon his great discovery than I do. I think all those who investigate telephonic effects will realize that we have touched upon the threshold of a new science, and that we have discoveries yet in store for us. I must confess that the explanation of the action of the microphone afforded by Mr. Preece and Mr. Willoughby Smith are to my mind not perfectly satisfactory. There are certain points in the telephone itself that may lead us to the true solution of this problem. If you fix your attention upon the first diagram shown by Mr. Preece, you have a constant source of electricity (the battery), a telephone, and this curious instrument. Now, the laws of audibility of the electric current by the telephone are analogous to the laws of induction. No sound is audible so long as your current is of uniform intensity. But the moment you change its intensity, you have a sound from the telephone. Conversely, when you have a sound from a telephone the intensity of the current passing through it has been changed; and the loudness of the sound is an index of the amount of change. Now, unless the microphone were itself a source of electricity, it is evident that the only way in which it can change the current is by varying the resistance of the

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circuit. So far we may be perfectly certain that the action of this instrument depends upon the variation of the resistance; and the only question as to how this variation of resistance can be accomplished, by the influence of such feeble sounds as those produced by the escapement of a watch, or the footsteps of a fly. As the sounds produced from the telephone are quite loud, the current must change very greatly in intensity, and the resistance of the microphone must vary in a most extraordinary manner, probably being at its maximum many times the resistance of the rest of the circuit, and at its minimum but a fraction of it. Mr. Preece seems to consider that the molecules of the substance composing the microphone change their shapes when subjected to compression by a variable force; and he has figured to us his conception of the alternate contraction and expansion of a chain of molecules under the influence of sound. Mr. Willoughby Smith, on the other hand, attributes the effects produced by the microphone to imperfect contact. He supposes the carbon points to rattle against one another under the influence of a sound, and he seems thus to regard the microphone as a delicate form of interrupter. I am more inclined to accept Mr. Willoughby Smith's explanation than that given us by Mr. Preece; but the reproduction of articulate speech negatives the assumption that the microphone acts as interrupter. The possibility of producing electrically any given quality of sound depends upon the possibility of producing a current of electricity, the intensity of which varies in a manner proportional to the varying velocity of a particle of air during the production of that sound. Hence, however much the points in contact may rattle together, the circuit must not be broken or the effect of quality will be lost and a mere noise be produced instead. If I might offer a suggestion, I think it probable that there is a variation in the amount of contact. Let us suppose an enormous number of particles to be in contact (each singly offering a high resistance to the passage of a current, but conjointly offering very slight resistance), then when the microphone rattles under the influences of a sound, a larger or smaller number of particles come into contact, and the resistance of the microphone changes without absolute break of circuit. Still we must not forget that at each increase of resistance, heat must be produced at the points of contact, and it is probable, nay, extremely likely, that heat has a great deal to

do with the results obtained. I was experimenting with a microphone the other day, and it kept on vibrating on its own account for nearly two minutes. A clear musical tone was emitted by the telephone in circuit with it. The microphone always exhibits a tendency towards vibration on its own account, when it is adjusted most delicately. The instrument, as I constructed it, consisted of a rod of charcoal placed horizontally, with its ends resting upon two other rods of charcoal. This arrangement, when shown to Professor Dewar, at once suggested to his mind Trevelyan's bars. I think it not at all unlikely that the microphone is in reality a species of Trevelyan's rocker, and that it may thus be in a condition to be affected by feeble sounds. It is quite conceivable that sounds too weak by themselves to throw the mass of the microphone into sensible vibration, may yet be sufficiently strong to start and control the vibrations due to heat, or at least it is conceivable that heat may assist the action of the sound. For instance, suppose the charcoals rattling together under the influence of a sound.

Now, as the charcoals separate, the resistance of the microphone increases, the points of contact become heated, and the expansion due to this cause occasions a greater separation than would otherwise take place. Thus heat may co-operate with a feeble sound to produce a greater amplitude of vibration at the points of contact than would be produced by the sound alone. Those who are interested in this subject would do well to read Professor Page's paper upon "The Vibration of Trevelyan's Bars by the Galvanic Current." The microphone recalls vividly to my mind some of the illustrations in this paper. Whatever may be the true explanation of the effects produced by the microphone, there is evidently a vast field open before us for inquiry. I will not take up your time with any further remarks, but will merely again offer my congratulations to Professor Hughes upon his discovery.

PROF. HUGHES: It seems that the description of the microphone is not well understood. I can excuse that, because it is as much as I can do to understand it myself; but as far as my experiments have gone, they show that the effects produced are the result of the increase and diminution of the resistance. Mr. Willoughby Smith designated it a commutator, and attributes the effects to contact.

That is quite right, only it is not from the point from which I view it, and that is the way in which the effects differ.

If we take a board like this (*illustrating*), and give it a blow here, that nail will jump up from the transmission of force. The same thing takes place in acoustic properties. A blow is simply rapid pressure, as distinguished from hydraulic pressure; the difference between a blow and hydraulic pressure is one of rapidity. If you take a piece of glass and put sand on it, and strike the glass, the sand will jump away and form figures. So it is here. (*Professor Hughes illustrated his views by means of diagrams on the board, showing the curves of articulated sounds, both in speaking and singing, etc.*)

THE PRESIDENT: As time is advancing, and as Mr. Preece, I believe, has some further experiments to exhibit, at the close of the meeting, I will make a few observations only on the very interesting matter which has been brought before us. The discussion that has taken place is remarkable for the excellent temper which has been shown between two great rival discoverers. I think all of us must have been pleased to have seen how these two gentlemen, Professor Bell and Professor Hughes, have described and brought before us their particular views regarding certain actions in the two instruments, the telephone and microphone, which, when we come to compare them, will be found to have many points of analogy, and though essentially different in detail, tend towards the accomplishment of the same important end. Mr. Preece and Professor Bell differ with regard to the action which takes place in the microphone; and Professor Hughes favors naturally the views which Mr. Preece had expressed; but I think there is probably not so much difference between these two views. It is quite evident that the action of the microphone is due to variation in electrical resistance produced by vibrations in an imperfect conductor, such as carbon, or an aggregate of divided pieces of metal, and the question for consideration is how this variation in resistance is effected. When two pieces of carbon are pressing one upon the other, and vibration is imparted to one of them, it is easily conceived that in consequence of this vibration the pressure between the adjoining points of the carbon will be modified, and in consequence of such variation in pressure, the electric conductivity of the carbon is also influenced, whilst,

according to Professor Hughes's application, the cause of variations in the electrical resistance must be looked for in the lateral increase of points of contact.

We have another discoverer who has already thrown light upon this subject, viz., Mr Edison of New York, the well-known discoverer of the phonograph, who, in constructing a form of telephone of his own, introduced carbon contact, which gave him resistances variable with the amount of physical pressure he brought to bear upon the carbon; and I must say that this question of varied resistance due to vibration will probably resolve itself simply into a question of pressure between particles of matter which are conducting in themselves, but which are held so lightly in contact that pressure is needed in order to establish conductive continuity.

I should have liked that something more had been said of this discovery of the microphone, with reference to its two elder sisters, the telephone and the phonograph, being of opinion that the three are only separate steps in the achievement of an advance in physical science which bids fair to be considered hereafter as one of great moment, not only as regards telegraphy, but as a means also of affording a more perfect insight into the nature of molecular action. We have heard from Mr. Willoughby Smith, that in substituting crystalline selenium for carbon in the microphone, a ray of light produces an effect analogous to mechanical vibration, and announces itself in a report comparable to a clap of thunder; and I can quite follow him in his arguments with respect to the matter.

His Grace the Duke of Argyll alluded to the application of this discovery to physiological research, and I could have wished that some of our learned physicians had taken up this point in the discussion, because I believe myself that the influence of these discoveries upon physiological research will be very great indeed. One thing has occurred to me in considering these matters, which I will take the liberty of mentioning. We have the remarkable effect of the phonograph producing a record of sounds simply from the indents given to a slip of tin-foil, which record can be reproduced at any time. This strikes me as being an exceedingly analogous case to the impress produced upon the brain by what we hear and see. An impress is produced, which for the moment seems lost, but which, in a vigorous mind, can be reproduced at any time. Now, the faculty of

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memory is not conceivable on any other hypothesis but that of a mechanical record being left on the brain, and stored up for perhaps half a century, to be restored in the succession in which it has been laid down; otherwise, how could the human mind reproduce impressions imparted years ago at will, or how could they be involuntarily revealed in our dreams? The discoveries which are now brought before us will undoubtedly serve to increase our stock of knowledge on physiological and metaphysical as well as physical subjects, regarding molecular action, of which we have hitherto had but very imperfect indications; and I think we cannot be too thankful to those gentlemen who have enabled us to discuss them as we have done, and I will therefore move that a hearty vote of thanks be given to Mr. William Preece for his communication. I think our thanks are also due to the two discoverers who are here to-night, and have given us the benefit of their views. I therefore propose that we also return our thanks to Professor Hughes and Professor Graham Bell.

The votes of thanks were unanimously accorded.

Mr W. H. Preece: My remarks will be very few. As I said when I spoke on the theory of the thing, I had not time to enter into it. In point of fact, there is no real difference between the views of Mr. Willoughby Smith, Professor Graham Bell and my own. The only difference is difference of language. Most differences in scientific controversies are attributable to difference of language. Whether variation of current is due to difference of contact or difference of pressure, matters very little, provided we use contact and pressure to imply the same thing. That which I call pressure, others call contact; and that which Mr. Willoughby Smith calls contact, I call pressure. It has afforded great pleasure to me to bring this matter before you. I have had, during the last twelve months, the pleasure of introducing before you the telephone, the phonograph, and now the microphone; and I hope next year, when we meet again, it will still be my pleasure to bring forward other new inventions and discoveries. I was anxious that Professor Hughes should have brought this subject before you himself; but, if I had not undertaken to do so, you would not have had it. Beyond assisting Professor Bell, Mr. Edison and Professor Hughes in any way I could, I can claim no merit of my own, either in respect to the telephone, the phonograph or the microphone.

The meeting then adjourned to the 13th of November.

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THOMSON & HOUSTON MICROPHONE RELAY.

From the Telegraphic Journal and Electrical Review, for Aug. 15, 1878, Vol. VI., pp. 343–345.

THE MICROPHONE RELAY.

BY PROFS. EDWIN J. HOUSTON AND ELIHU THOMSON, OF THE PHILADELPHIA CENTRAL HIGH SCHOOL.

Immediately after the announcement by Prof. Bell of his remarkable invention of the articulating telephone, we proposed for ourselves the task of relaying this instrument. Quite a number of different arrangements were tried, but, owing to the exceedingly feeble movements of the diaphragm of the receiving telephone, none of them were very successful. The discovery by Prof. Hughes, however, of the inexpressibly delicate microphone, happily afforded us the means of at last solving the problem at which we had been so long engaged.

In our application of the microphone for the relaying of the telephone, we attach a miniature microphone to the plate of the receiving telephone. The microphone so attached consists essentially of three small pieces of carbon, each being about three eights of an inch in length. These pieces are arranged exactly as in the manner described by Prof. Hughes, viz., one of the pieces of carbon, which is sharpened at both ends, rests vertically in small cavities near the ends of the two other pieces, as shown in Fig. 1. The two carbon supports for the third piece are cemented at their ends directly to the plate of the telephone.

The microphone so constructed is placed in the new circuit in which it is desired to repeat the message originally transmitted. The method of its operation is evident. The slight movements of the diaphragm of the receiving telephone, which are, in fact, so slight as to render them almost impossible of detection by mechanical means, are nevertheless at once recognized by the marvellously sensitive microphone, and are repeated in the new circuit as variations in the intensity of the electrical current traversing it. The message so relayed or repeated, for it is evident that the instrument can be used either as a relayer or a repeater, may be either received at once by a

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telephone placed in said circuit, or may be again repeated in a new circuit. By this means we believe that the distance to which a telephone message can be transmitted will be very greatly increased.

Owing to the extreme sensitiveness of the microphone, it will be necessary, in the practical application of this instrument as a relay, to carefully shield it from all extraneous sounds, which, weak though they may be, are nevertheless very loud when compared with those which would be produced by the feeble movements of the plate of the receiving telephone. This may be obtained in practice in several ways, as, for example, by placing the microphone relay in a box with double or treble hollow walls lined with cotton, wool, or some other non-homogeneous material, or by sinking the instrument in a pit under ground. We have found but little difficulty, however, in the trial of our instrument over a city line of some three miles in length, of obtaining the quiet necessary for the working of the instrument, although the latter was placed in a large room in the second story of a building facing a public thoroughfare, and the time of trial was shortly after midday.

The microphone, when properly constructed, has its greater sensitiveness when the piece of carbon, pointed at both ends, rests in a nearly vertical position. Its electrical resistance is then at its maximum. In this position the upright carbon is resting on its extreme ends, and the cross section of contact a minimum. So placed, the slightest acoustic movement brings portions of the conical surfaces of the upright pieces against the edges of the cavities, and thereby diminishes the resistance by increasing the area of the surfaces in contact. If now it be desired to diminish the sensitiveness of the instrument, it is only necessary that it be so placed that the upright carbon be no longer supported vertically, but be slightly inclined. In this position more force is required to move the upright piece, and so cause it to vary the electrical resistance. In all the microphones that we have experimented with when the upright piece was held nearly vertically, whispers or other faint sounds were distinctly transmitted, but the voice of a person standing a few feet from the instrument, and speaking as in ordinary conversation, caused such a rattling of the receiving instrument as either to render the sound unintelligible or greatly confused. In all such cases a certain in-

clination could be obtained, varying slightly in each instrument, at which the rattling of the instrument entirely disappeared, and the sound was distinctly and loudly transmitted.

When the microphone relay is placed in a circuit whose resistance is considerable, as, for example, at the end of a distant station, we increase the sensitiveness of the instrument by attaching a number of minute microphones to the receiving diaphragm, as shown in the figures. These may be connected in series, as in Fig. 3, or in multiple arc, as in Fig. 2.

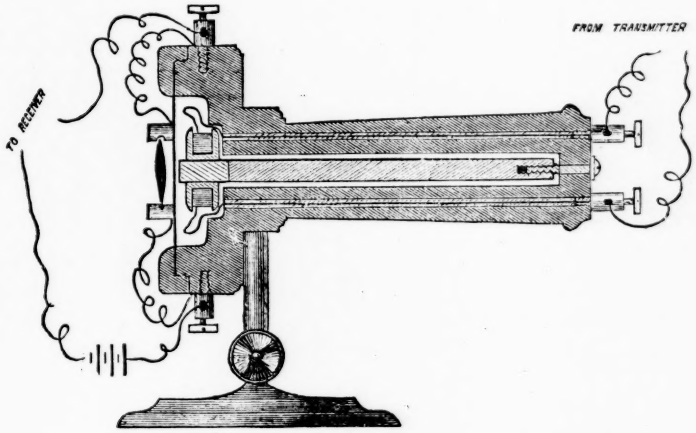

FIG. 1.

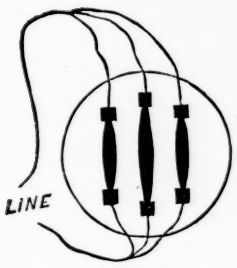

FIG. 2.

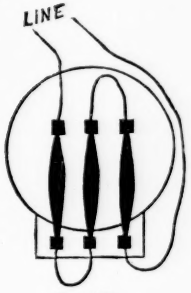

FIG. 3.

Since the variation in the electrical resistance of the microphone depends mainly on the upper contact of the loose piece with its support, an increased delicacy may be obtained by attaching this support directly to the middle of the diaphragm of the receiving

instrument, while the lower support need not necessarily be attached to the diaphragm.

We have measured the resistance of a microphone, in which the movable piece was composed of a piece of carbon about one and a quarter inches long and a quarter of an inch square, and find that when placed in an upright position it has a resistance of about fifty ohms, varying, however, in a marked manner, with any sound. The same instrument, when turned at an angle of about 40° from the vertical, was found to have its resistance diminished to about twenty-five ohms.

It may be mentioned, as an interesting fact in regard to the micro phone, that when the upright piece is placed in the position of its greatest sensitiveness, and a moderately loud sound is made near it, although such sound is only transmitted as a confused rattling, yet its resonance can, in most cases, be distinctly heard. This is probably the cause of the peculiar ringing sound heard when the microphone transmits mere noises, such as those produced by a person walking.

DEPOSITION OF FRANK L. POPE.

FRANK L. POPE, a witness produced and sworn on the part of the complainants, deposes as follows: —

Direct Examination by Mr. DICKERSON.

Int. 1. What is your age, residence, and occupation?

Ans. I am forty-four years of age, and I reside at El Mora, N. J., and am by profession a solicitor of patents, having an office at 59 Wall Street, in New York City.

Int. 2. Before 1860, what was your occupation and your residence?

Ans. I was a telegraph operator, and resided in Springfield, Mass., where I was employed by the American Telegraph Company.

Int. 3. At what time did you come to New York?

Ans. In January, 1860.

Int. 4. In what employment did you enter here?

Ans. I went into the employment of Munn & Co., of 37 Park Row, New York, solicitors of patents, and was employed by them as a draughtsman, and occasionally assisted in the editorial work on the *Scientific American*, which was published by them.

Int. 5. Did you become acquainted with Alfred G. Holcomb at that time, and how?

Ans. I became slightly acquainted with him; that is to say, I knew him from seeing him in the office on business. He was at that time engaged in prosecuting an application for a patent for a telegraphic relay, and came in the office from time to time to see about it. I suppose Munn & Co. had charge of his business as patent solicitors. On one or more of these occasions I met him.

Int. 6. Will you explain the situation of the Morse telegraphic patents at that time, and what was the subject to which the inventors were paying attention in respect to telegraphic apparatus?

Ans. Prior to the latter part of 1859, there were two competing telegraph companies between New York, Boston, and Portland, between which the business was pretty equally divided. One was the American Telegraph Company, working under House's patents;

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We have measured the resistance of a microphone, in which the movable piece was composed of a piece of carbon about one and a quarter inches long and a quarter of an inch square, and find that when placed in an upright position it has a resistance of about fifty ohms, varying, however, in a marked manner, with any sound. The same instrument, when turned at an angle of about 40° from the vertical, was found to have its resistance diminished to about twenty-five ohms.

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Ans. Prior to the latter part of 1859, there were two competing telegraph companies between New York, Boston, and Portland, between which the business was pretty equally divided. One was the American Telegraph Company, working under House's patents;

the other was the New England Union Company, working under the Morse patents. About the 1st of December, 1859, the American Company acquired control of the New England Union Company, thus consolidating all the lines in one interest. The foundation patent, under which the Morse system was carried on, was near its expiration, June 20, 1861, and Boston capitalists were engaged, during 1860, in organizing a company to build a competing line between Portland and New York, and have it ready for business by the time the Morse patents expired. The subsidiary Morse patent, covering the local circuit and relay, would not, however, expire until April 11, 1867. Hence it became a desideratum for the proposed competing company to secure some apparatus which would operate efficiently without the aid of a local circuit, and during 1860 and 1861 quite a number of inventors were at work on this problem. Among those of my own acquaintance were Samuel F. Day, of Ballston, N. Y.; Dr. Leverett Bradley, of No. 30 Pine Street, New York City; James J. Clark, of Philadelphia; John E. Smith, of Poughkeepsie; and I supposed at the time that Mr. Holcomb's apparatus was designed for the same purpose.

[*Defendants' counsel objects to the last clause of the witness's answer, as to what he supposed.*]

Int. 7. Did you see Holcomb's apparatus experimentally tried for that purpose?

Ans. I cannot say positively, although I have a strong impression that I did see a trial made of one of his instruments in one of the telegraph offices in New York.

Int. 8. Did you see the instrument in one of those offices?

Ans. I remember seeing the instrument, and I am quite sure it was in one of the telegraph offices, either at the corner of Nassau and Cedar Streets, or at the corner of Wall and Broad Streets. My recollection, however, is not distinct as to where I saw the instrument.

Int. 9. You spoke of Dr. Leverett Bradley. State what you know of him and what association you had with him.

Ans. I first met Dr. Bradley in the American Telegraph office, 21 Wall Street, corner of Broad, in the early part of 1860. He

was an elderly gentlemen, very much interested in scientific pursuits, and especially in electrical and telegraphic apparatus, which was a sort of a hobby with him. After making his acquaintance, I frequently went, upon his invitation, to his work-shop, which was in the front attic of the building No. 30 Pine Street, and became very much interested in his work. I conversed with him a great deal about telegraphic apparatus, inventions, and systems. He was always ready to talk on that subject, and in fact could be induced to talk about little else. I left the city in April, 1861, and went to Providence, R. I., where I remained until the latter part of the following winter, that is to say, the early part of 1862, when I returned to New York and became an assistant in the office of General Marshall Lefferts, then engineer of the American Telegraph Company, at 145 Broadway. After I had been in New York a few months, at the solicitation of Dr. Bradley, with whom I had kept up my acquaintance by correspondence and otherwise, I went to board in the family of Mrs. Jane Reed, a widow living at No. 7 Exchange Place, Jersey City, with whom Dr. Bradley was at that time boarding. He then had his workshop in the upper story of the same building, and was engaged in manufacturing for sale his patented telegraphic relays and sounders. I remained in this family until the spring of 1864, when I removed to Brooklyn. I was very intimately associated with Dr. Bradley while we were boarding in the same house in Jersey City, and we were constantly discussing telegraphic inventions and other similar matters of mutual interest. My acquaintance with Dr. Bradley continued until his death, which took place, I think, in 1875.

Int. 10. During that time did you ever hear from Dr. Bradley, or Mr. Holcomb, or Marshall Lefferts, that they had or had seen a speaking telephone?

Ans. I never heard of such a thing, or a suggestion of such a thing from either of them.

Int. 11. In 1877 what was your occupation and position?

Ans. In 1877 I was in the service of the Western Union and Gold and Stock Telegraph Companies, as an expert and patent solicitor. I had charge of the business of both these companies in the PatentOffice, and was also employed to make examinations of

inventions which were presented to the companies for adoption. I entered this service in 1875, and remained there until 1880.

Int. 12. When did the Western Union Telegraph Company, or its associates under it, begin to use the Bell telephone?

Ans. Some time in 1877.

Int. 13. What action was taken by the owners of the Bell patent in regard to it?

Ans. A suit was brought by them against the agent of the Gold and Stock Company in Boston, Peter A. Dowd, alleging an infringement of the Bell patents by the instruments which had been manufactured and issued by the Gold and Stock Telegraph Company. The bill was filed Sept. 12, 1878, and the answer was filed Nov. 4, 1878.

Int. 14. What was the relation between the Gold and Stock Telegraph Company and the Western Union Telegraph Company?

Ans. The Gold and Stock was a subsidiary company, of which the majority of the shares were held by the Western Union Company, the latter company controlling the policy and management of the former.

Int. 15. State what connection you had with that lawsuit, and under whose directions.

Ans. In the summer of 1877 — I should say about the 1st of August — I was directed by Mr. William Orton, president of the Western Union Company, to ascertain if there were any patents or inventions which could be acquired by our company, which were necessary to the operation of the speaking telephone, and also to get hold of any facts or information which might aid us in making a defence against a suit which it was expected would be brought by the owners of the Bell patents.

Int. 16. Will you produce a copy of the answer in the Dowd case, or so much of it as sets up the prior inventors?

Ans. I produce it; it is as follows: —

"And this defendant, further answering, on information and belief, denies that said Bell was the original and first inventor of the alleged improvement specified as his invention in said Letters Patent, numbered 186,787, and avers that long before any invention thereof by him, the same was known to and used by Elisha Gray, now of Highland Park, Illinois, at the city of New York, at Oberlin and

Cleveland, Ohio, and at Highland Park and Chicago, Illinois; by Thomas A. Edison, now of Menlo Park, New Jersey, at the City of New York and at said Menlo Park; by Amos E. Dolbear, now of Somerville, Massachusetts, at said Somerville; by Alfred G. Holcomb, now of Granby, Connecticut, at said City of New York; by Philip H. Vanderweyde of said City of New York, at said city; by W. F. Channing, of Providence, Rhode Island, at said Providence; by the United States Telegraph Company at Pittsburg, Pennsylvania, which company was located at said Pittsburg; by George A. Hamilton, now of Elizabeth, New Jersey, at said Pittsburg."

Int. 17. What did the Western Union Company do in respect to the rights of Elisha Gray, Thomas A. Edison, and Amos E. Dolbear, claiming to have invented something in connection with telephones?

[*Objected to as incompetent and immaterial.*]

Ans. Edison was, in one sense, an employee of the company; that is to say, he was under a contract to make inventions for them, and he was set at work inventing improvements on the telephone. The rights of Prof. Dolbear were purchased by the company under a contract; and a similar contract was afterwards made with Elisha Gray, upon my recommendation, as I believed that some of his inventions were important for our purpose.

Int. 18. When was the testimony begun in that case?

Ans. In 1879, in the spring or early part of the summer.

Int. 19. Before the testimony was taken in that case, did you have an interview with Alfred G. Holcomb, who was set up in your answer?

Ans. I did, at my office in the Western Union building.

Int. 20. What was the object of that interview?

[*Objected to as immaterial and incompetent.*]

Ans. Mr. Holcomb came to me (I think he was referred to me by Mr. Orton, or Mr. George Prescott, the electrician of the Western Union Company, although it is possible he may have come directly to me in the first instance) with certain inventions in the way of telephones, which he said he had made at a very early date; and I understood the object of his visit to be to dispose of his rights to the Western Union Telegraph Company. Before entering into any arrangements of this kind, the matter was usually submitted by the officers of the telegraph company to me for investigation.